

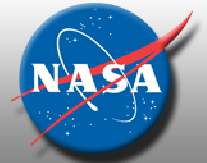


# **SN Gateway System Requirements Review**

User Services Upgrade  
GPM and RBSP Mission Support



# Export Control



- **TDRS Ground Station technical information is subject to International Traffic in Arms Regulations (ITAR) because it is on the US Munitions List**
  - Category XV—Spacecraft Systems and Associated Equipment
  - Supporting U.S. Armed Forces
- **All data in the SN Gateway SRR is rated at EAR99 (uncontrolled)**
  - Does not provide information required for design or development
  - Information is available in public domain



# SN Gateway SRR Agenda



November 16, 2009

## **SECTION**

## **PRESENTER**

**Sec 1.0 Introduction & Project Overview**

**P. Boldosser**

**Sec 2.0 Programmatic**

**P. Boldosser**

> Organization/Staffing

> Schedule

**Sec 3.0 Systems Engineering**

**C. Finegan / J. Ramirez / M. Cates**

> CONOPS

> Context

> Requirements

> Interfaces

> Functional Architecture

> Verification & Validation

> Integration & Test

**Sec 4.0 Risk Management**

**P. Boldosser**

**Sec 5.0 Wrap Up & AI Review**

**F. Herman**

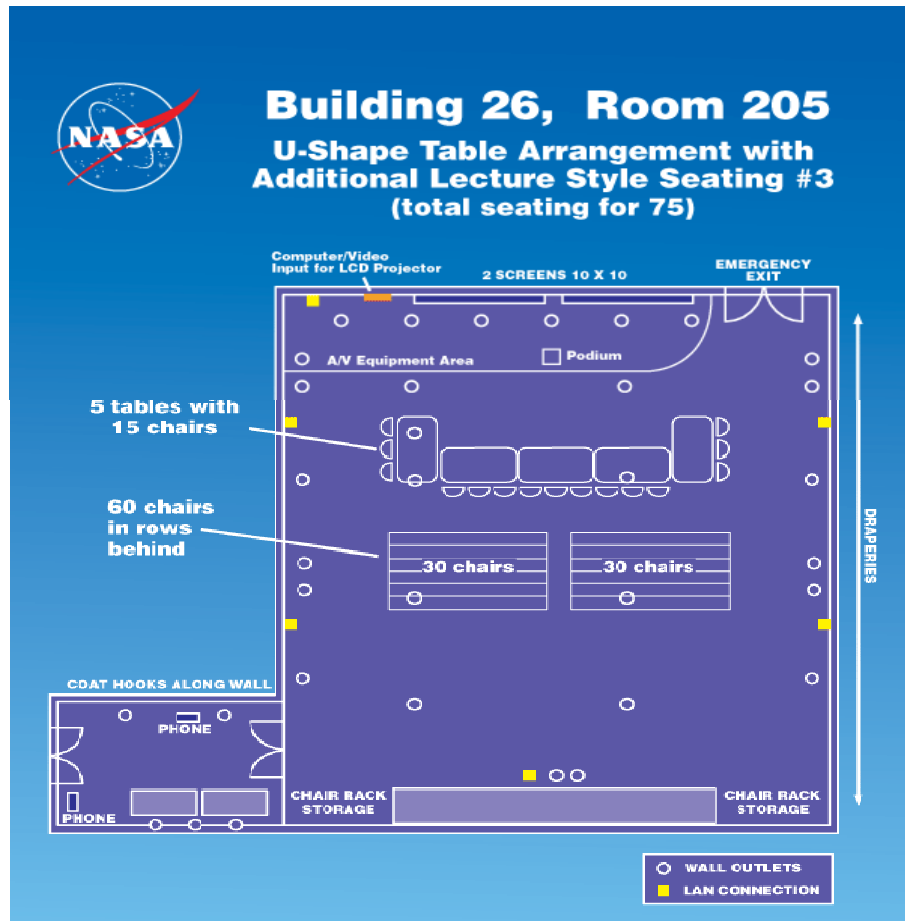
> SRR Success Criteria



# **Section 1.0**

## **Introduction & Project Overview**

**Pat Boldosser**



- Emergency Exits are located through the entrance/exit doors and down the stairs.
- Restrooms
  - The Ladies' Room is just down the hall; turn right from 205 lobby, turn right at first intersection. The women's room is on the left.
  - The Men's Room are located directly across from the conference room entrance.



# Review Members



- Harry Shaw      Review Board Chair, GSFC SN USU Project Manager
- Mike Rackley      SN Systems Engineer
- Dan Hein      WSC Deputy Station Director
- Madeline Butler      Code 450 Deputy Chief Engineer
- Deane Sibol      Radiation Belt Storm Probes Project Representative
- Tim Rykowski      Global Precipitation Monitor Project Representative
- Frank Herman      Managing Director, Fraunhofer Center Maryland
- Jerry Esper      Code 450 Computer Security Official
- Chris Spinolo      NISN Information System Security Official (alternate)



# Purpose of the Review



- **Examine the functional and performance requirements defined for the Space Network (SN) Gateway (SNG) system to support Radiation Belt Storm Probe (RBSP) and Global Precipitation Measurement (GPM)-Core missions**
- **Ensure requirements and selected concept satisfy the SNG mission**
- **Ensure preliminary SNG V&V concept has been identified**
- **Ensure major SNG risks have been identified and viable mitigation strategies have been defined**



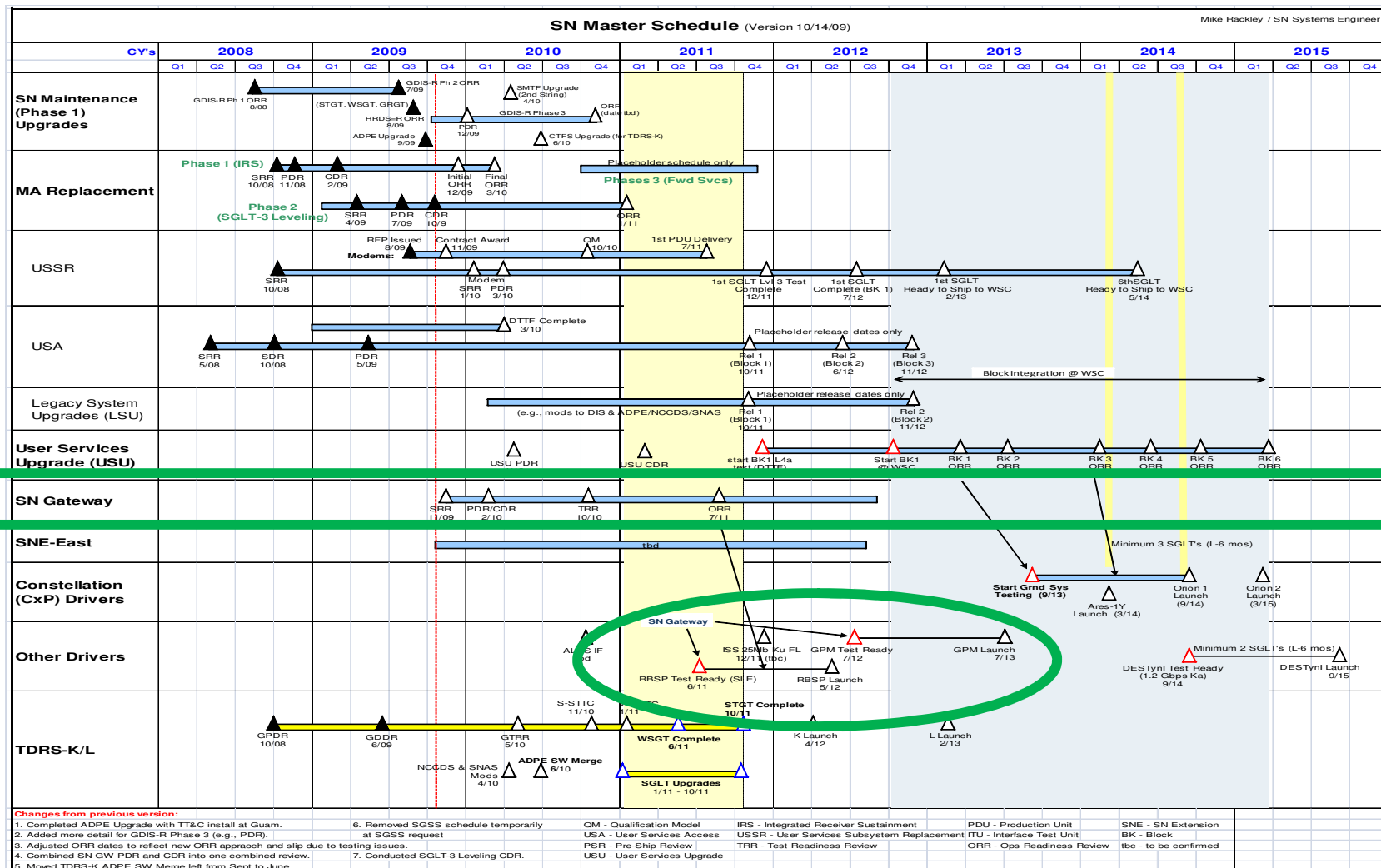
# Background



- **Space Network Ground Segment Sustainment (SGSS) has been chartered to upgrade/replace the Space Network Ground Segment.**
- **SGSS will not be in place in time to support Constellation (CxP) Mission Requirements**
  - User Services Upgrade (USU) Project has been initiated to respond to CxP
  - USU consists of User Services Access (USA) and User Services Subsystem Replacement (USSR)
- **RBSP and GPM mission requirements are also not supported by current SN posture**
  - USU will not be in place in time to support these missions
- **SN Gateway initiated to provide manual (non-automated control) functionality to support RBSP and GPM-Core**
  - Manually operated by SN Operational personnel – man-in-the-loop
  - Space Link Extension (SLE) services for RBSP
  - White Sands Complex TCP/IP Data Interface Service capability (WDISC)-like services for GPM, but at higher data rates

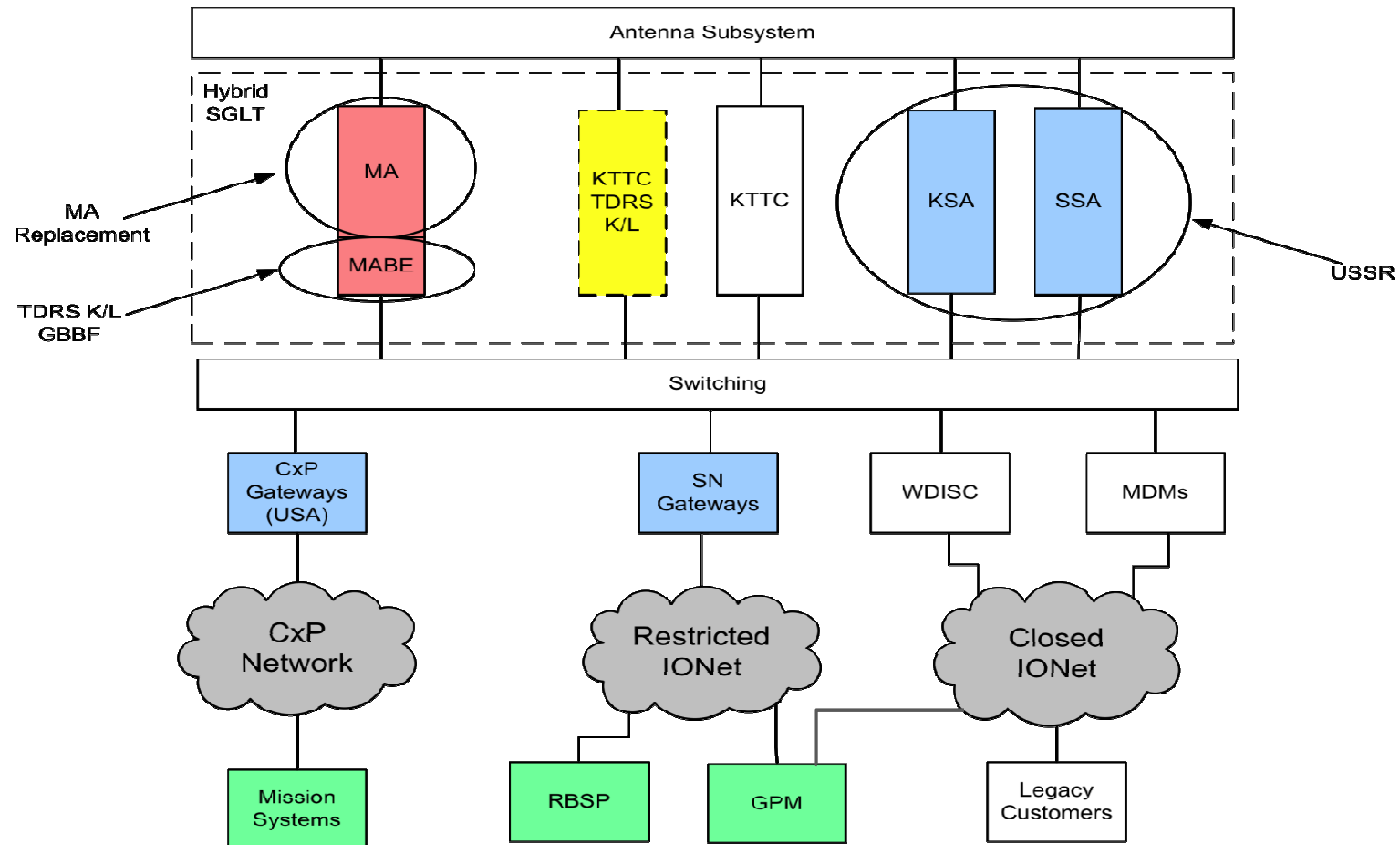


# SN Integrated Schedule



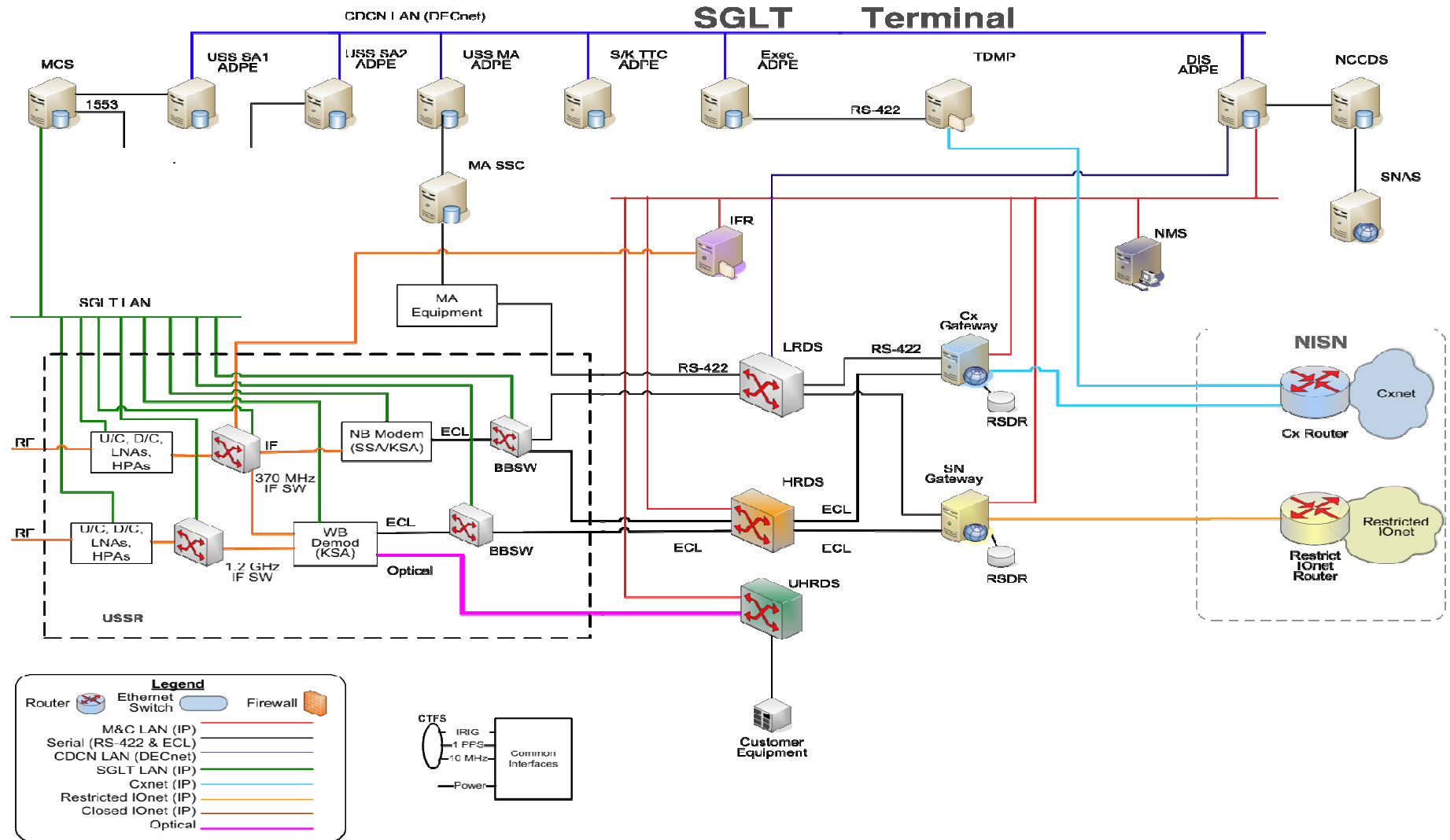


# SN Maintenance Projects



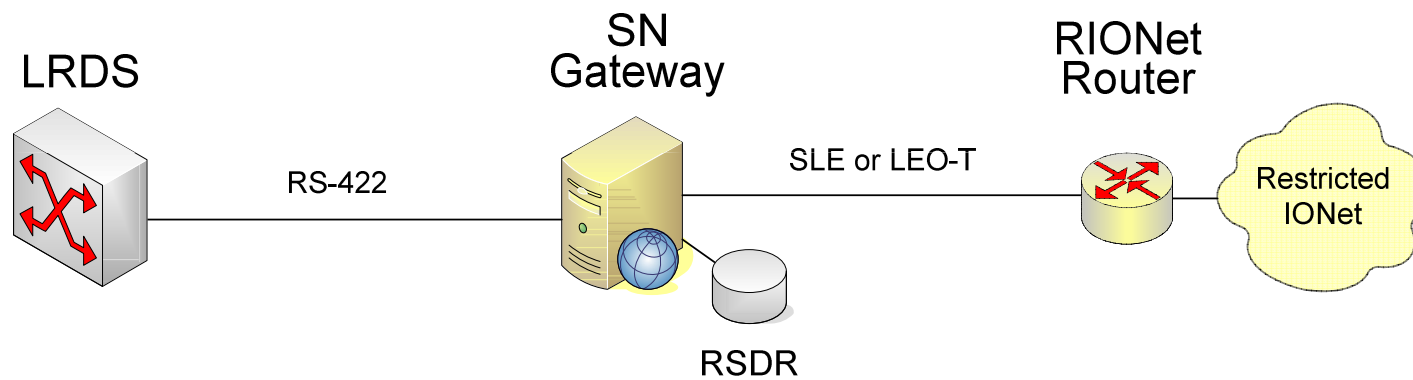


# USU Architecture





# SN Gateway Reference Architecture



\* Redundancy not shown.



# SRR Entrance Criteria



Item	Status
Successful MCR with responses to RFAs	N/A
Approved SRR Agenda and Success Criteria	Approved by Harry Shaw and following NASA SP 6105
System Requirements Document	Mature draft delivered (MSES2A-RPT-0367-0002)
System Software Functionality Description	Implement LEO-T and SLE Services from applicable specs
Concept of Operations (CONOPS)	Presented in SRR
Updated Mission Requirements	Captured in the SRD and reviewed with customers
Baselined SEMP	Delivered 452-SEMP-USA
Risk Management Plan	Adhering to SN Risk Management Plan
Preliminary Requirements Allocation to next Lower Level	Presented in SRR
Updated Cost Estimate	Worked with customer; outside scope of this review



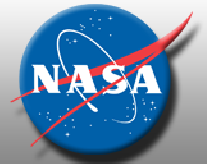
## SRR Entrance Criteria (cont'd)



Item	Status
Technology Development Plan	Solution based on COTS implementation
Updated Risk Assessment and Mitigations	Risks are updated and reported to the SN SEWG per Plan
Logistics Documentation	Approached presented in SRR
Human Rating Plan	N/A
Software Development Plan	N/A; COTS-based solution with verification
System Safety and Mission Assurance Plan	Adhere to SGT Policies MSES2A-PLAN-0029 & 0032
Configuration Management Plan	Adhering to USA CM Plan NENS-ED-PLAN-0017
Verification & Validation Approach	Presented in SRR
Preliminary System Safety Analysis	Presented in SRR



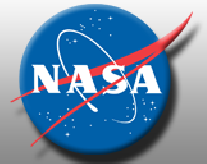
# **SRR Success Criteria**



- **Sound process for requirements allocation and control**
- **Defined plan to complete definition within schedule**
- **Allocation and derivation of key requirements complete down to subsystem level**
- **Major external and internal interfaces defined**
- **Preliminary V&V approach defined**
- **Major risks identified and assessed, viable mitigation strategies defined**



# Review Process Ground Rules



- **Actionable RFAs may be written by any party and are to be submitted to the review board no later than COB November 17<sup>th</sup>**
- **The board will meet following the review to assess RFA validity**
- **RFAs shall be written to:**
  - Revise, delete or add requirements
  - Document where requirements will not meet intended mission
- **RFAs shall not be written to:**
  - Document editorial changes
  - Document pre-declared or planned open work
- **NASA Task Manager and the MSES Project Manager will meet to assign accepted RFAs to team members for response and action**
- **Responses will be prepared by the assignee and coordinated with the originator for their acceptance or rejection**



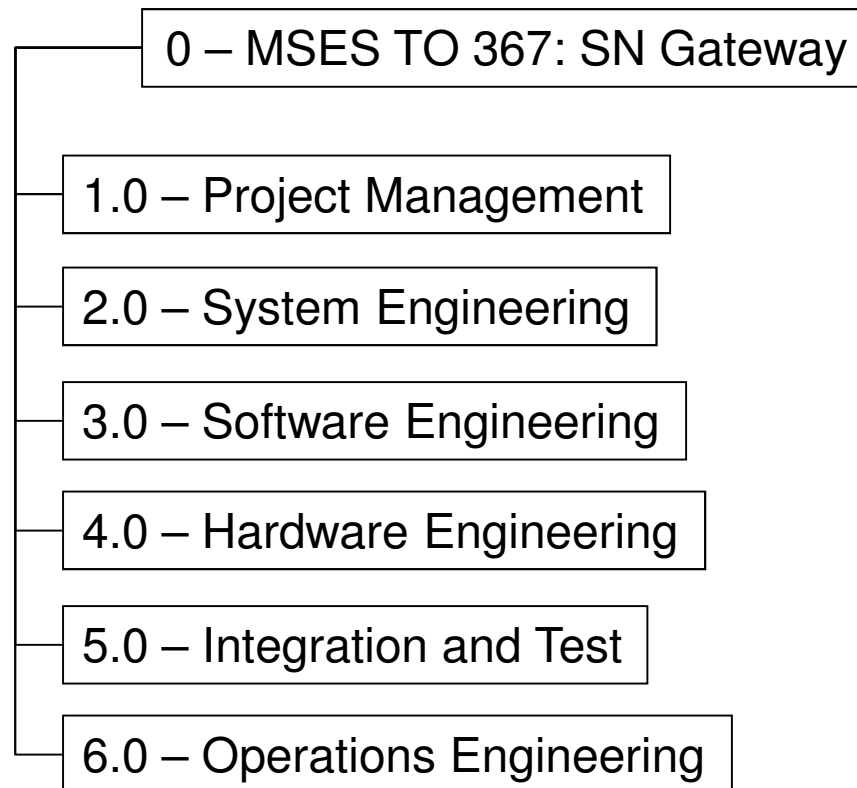
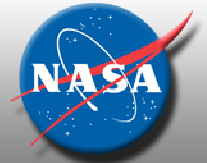
# **Section 2.0**

## **Programmatics**

### **Pat Boldosser**

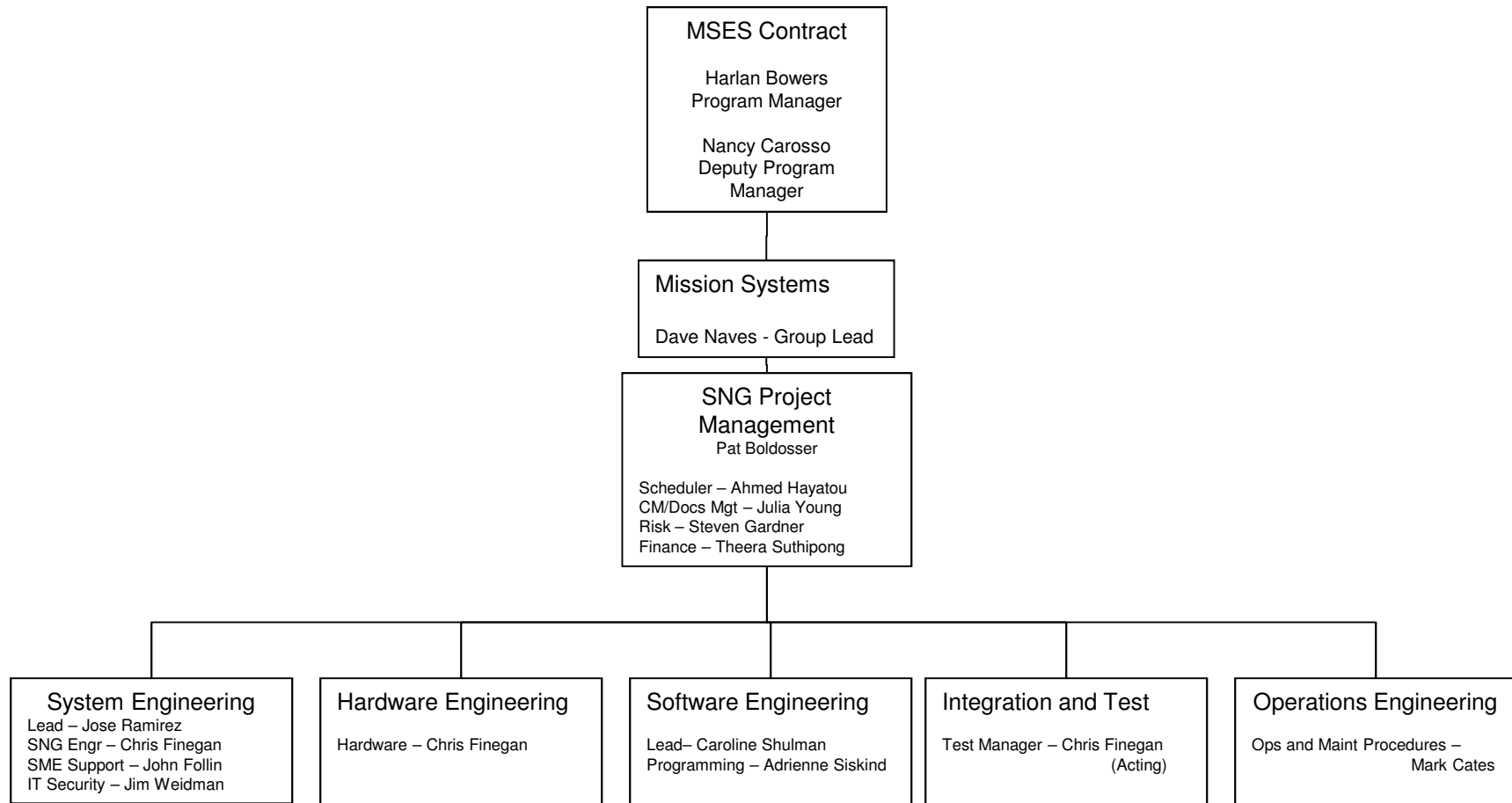


# SN Gateway WBS





# Implementation Organization & Staffing





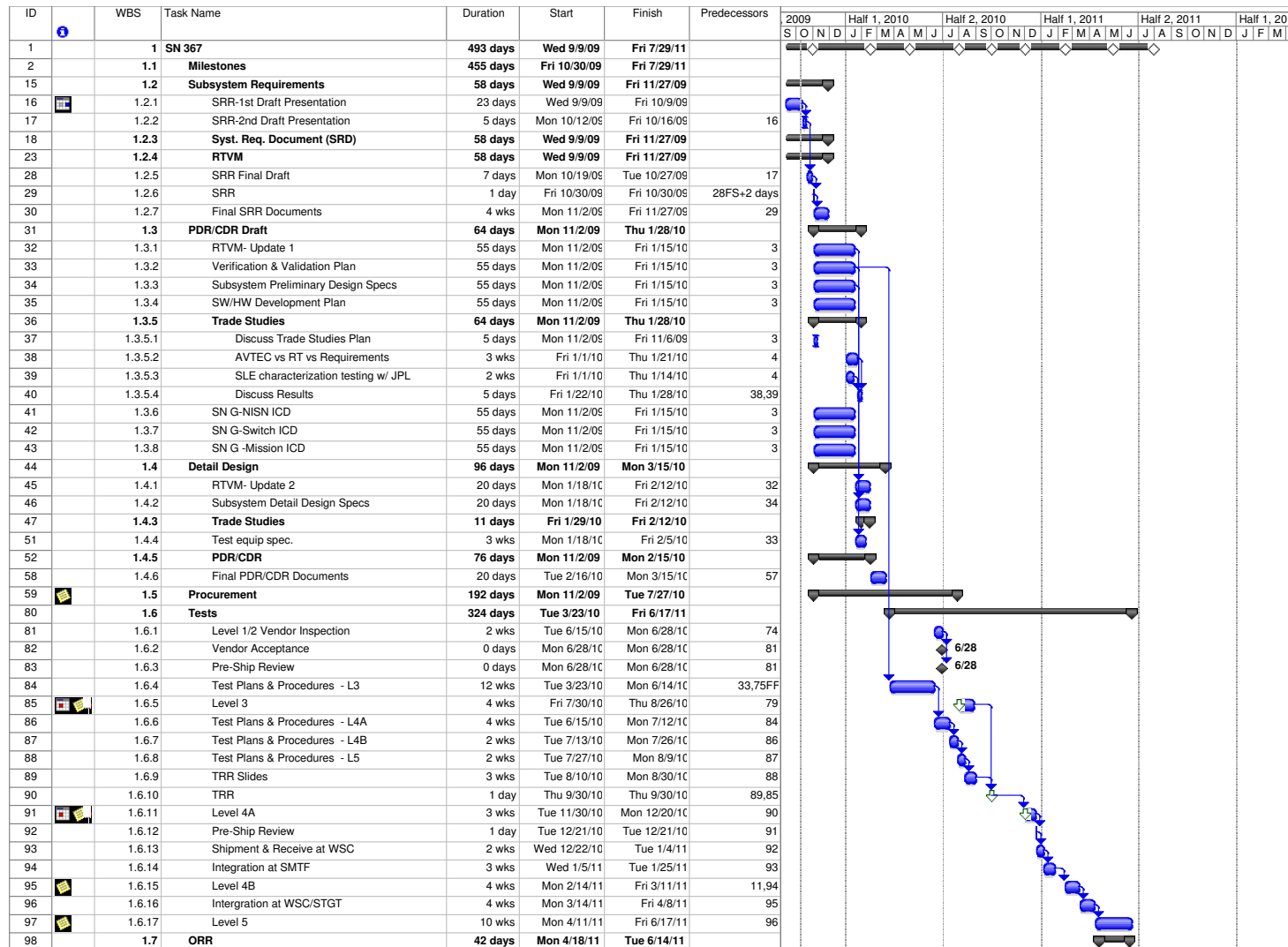
# SN Gateway Project Schedule Milestones

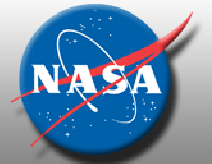


- System Requirements Review 11/16/2009
- Preliminary Design Review /  
Critical Design Review 2/15/2010
- SNG/SLE Vendor Awarded 4/30/2010
- Test Readiness Review 9/30/2010
- Operational Readiness Review 7/30/2011
- RBSP Launch 5/18/2012
- GPM Launch 7/21/2013



# SNG Proposed Implementation Schedule





# **Section 3.0**

## **Systems Engineering**

**Chris Finegan**  
**Jose Ramirez**  
**Mark Cates**



# Systems Engineering Agenda



## **SECTION 3.0**

**Sec 3.1 CONOPS**

**Sec 3.2 Context**

**Sec 3.3 Requirements**

**Sec 3.4 Interfaces**

**Sec 3.5 Functional Architecture**

**Sec 3.6 Verification & Validation**

**Sec 3.7 Integration & Test**



## **Section 3.1**

### **CONOPS**



# CONOPS



- **Mission Scheduling**
- **Configuration**
- **Monitor & Control**
- **Pre-pass Activity**
- **Pass Activity**
- **Post-pass Activity**
- **Error Handling**



# Mission Scheduling



- **Mission Operations Centers schedule support**
  - Space Network Access System (SNAS)
  - Network Control Center Data Systems (NCCDS)
- **SNG operator reviews upcoming contacts, manually performs pre-pass, pass, post-pass activities**
- **Operation appears automatic to mission MOCs**



# CONOPS - Configuration



- **Configurations tested in DTTF then SMTF per mission**
- **Approved, under Configuration Control, deployed to field sites**
- **Stored in SN Gateway**
- **Operator selects configuration based on pre-mission planning**
- **Granular and scalable scope**
  - Single subsystem
  - Combination of subsystems
  - Entire SN Gateway
- **Compatibility between SN Gateways**



# CONOPS – Monitor & Control



- **Local and manual operation**
- **Nominally performed by WSC Operations personnel**
- **Operator interface options include:**
  - Application on SNG
  - Client on workstation
  - Web



# CONOPS – Pre-pass Activity



- **Mission schedules support via SNAS**
- **Operations personnel at supporting Terminal**
  - Load configuration on Prime & Redundant SNGs
  - Accept IP connections to MOC nodes
    - RBSP – SLE
    - GPM – LEO-T over TCP/IP
  - Activate SNGs pre-pass



# **CONOPS – Pass Activity**



- 1. Pass return service data to MOC**
- 2. Record return service data**
- 3. Pass forward service data to spacecraft if necessary**
- 4. Monitor equipment for failures**
- 5. Respond to MOC notifications of failures**
- 6. Switch to hot backup if necessary**



# CONOPS – Post-pass Activity



1. **Deactivate SNGs after end of pass**
  - Verify that MOC IP connections terminated
2. **Deconfigure SNGs**
3. **Support Offline Delivery requests**



# CONOPS – Error Handling

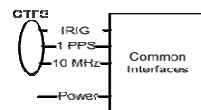
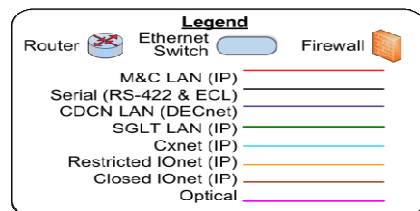
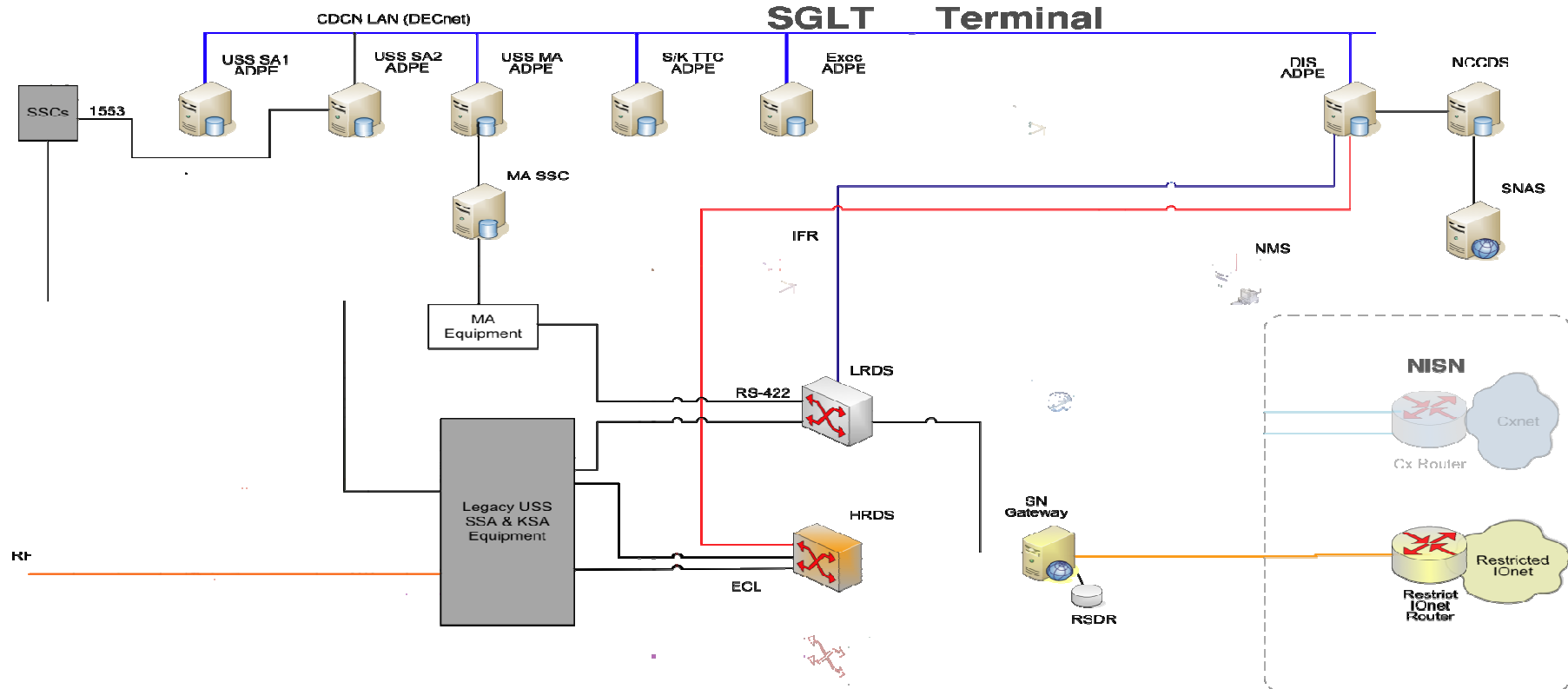


- **SNGs configured**
- **IP connections established between SNG and MOC**
- **MOC monitors status/heartbeats**
- **Redundant SNG activated if necessary**
- **Data always recorded, used as fallback if MOC connection fails during pass**

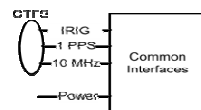
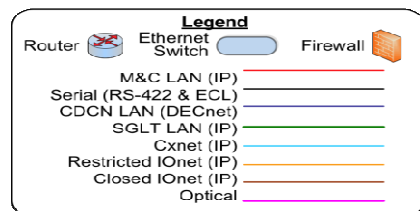
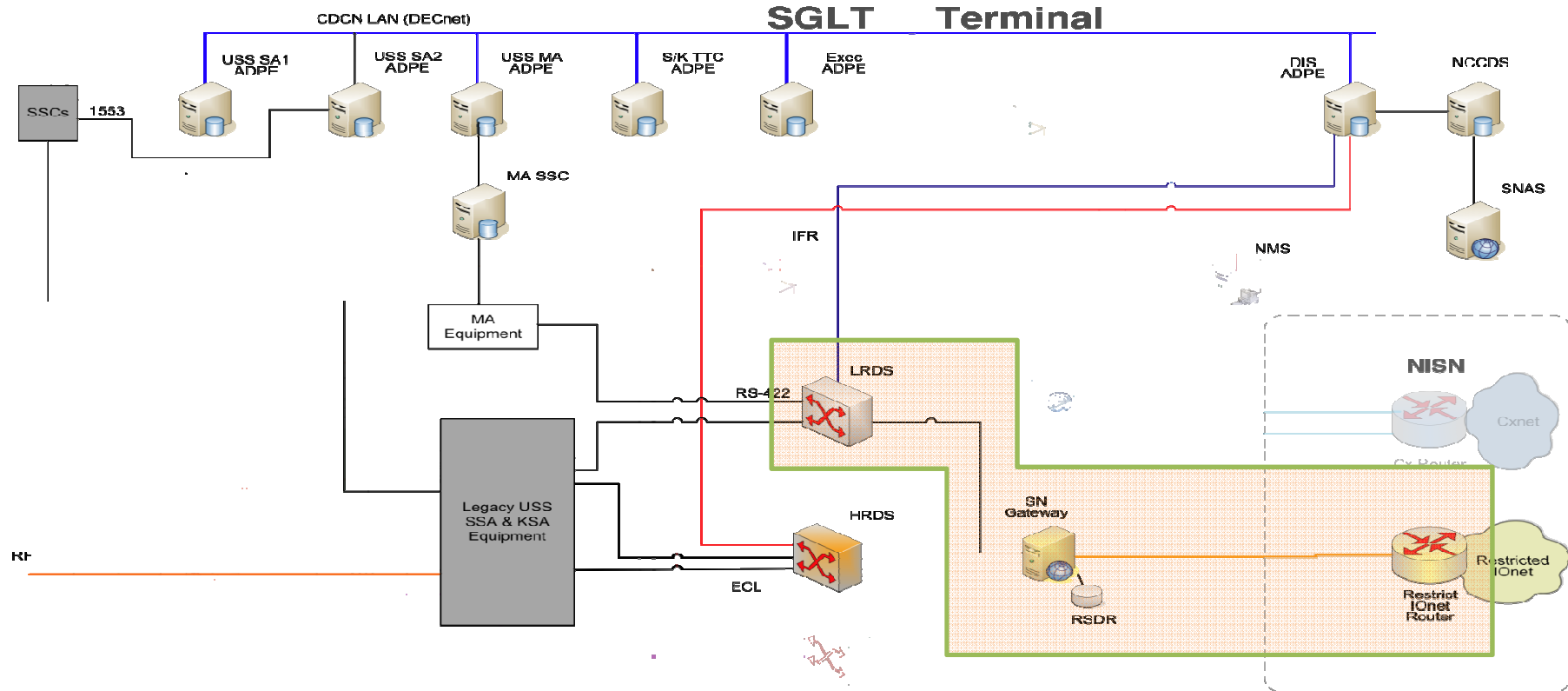


## **Section 3.2**

# **Context & Mission Data Flows**



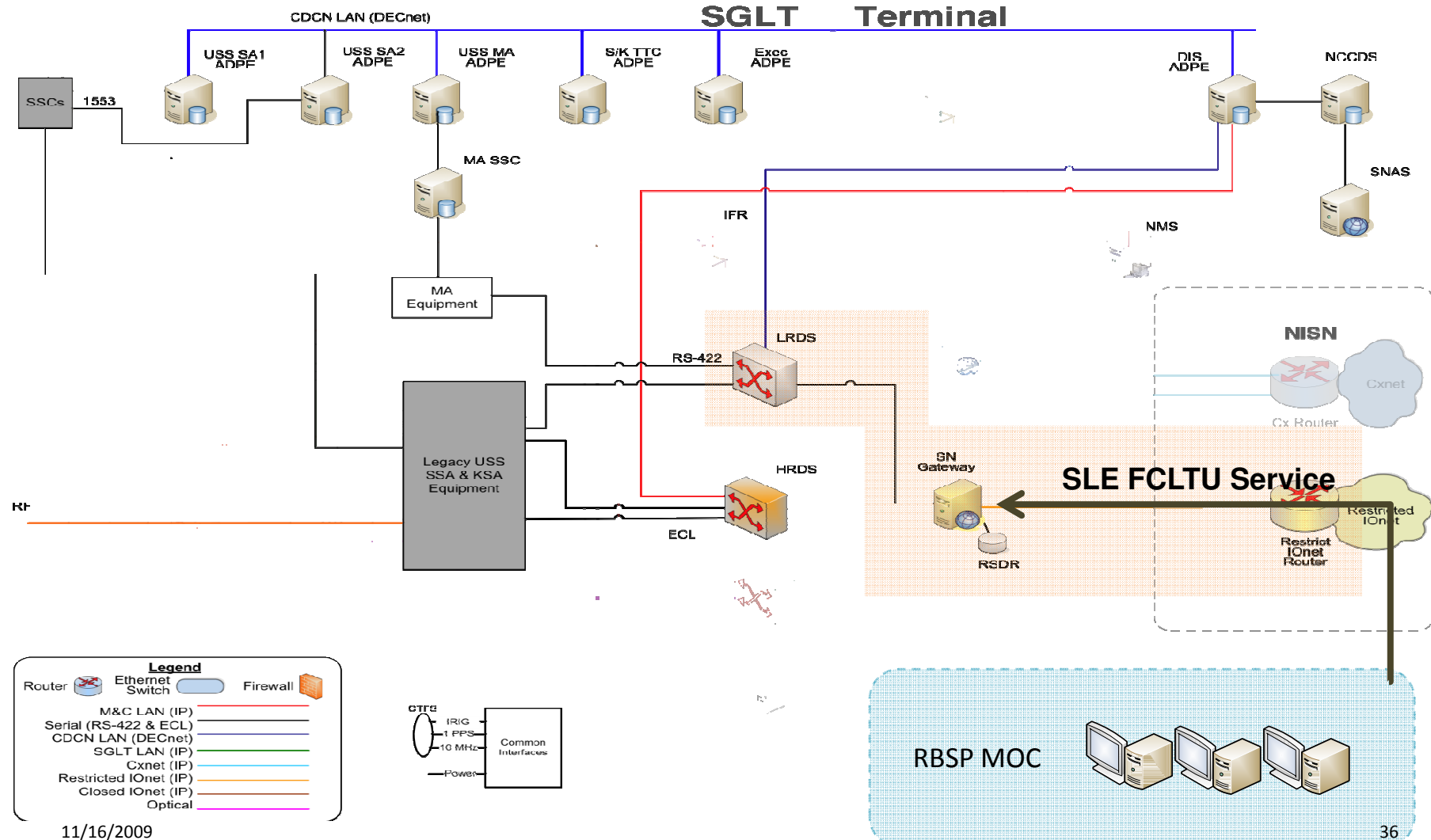
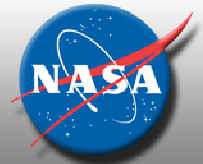
Architecture diagrams courtesy of Larry Kiser / Perot Systems.



Architecture diagrams courtesy of Larry Kiser / Perot Systems.



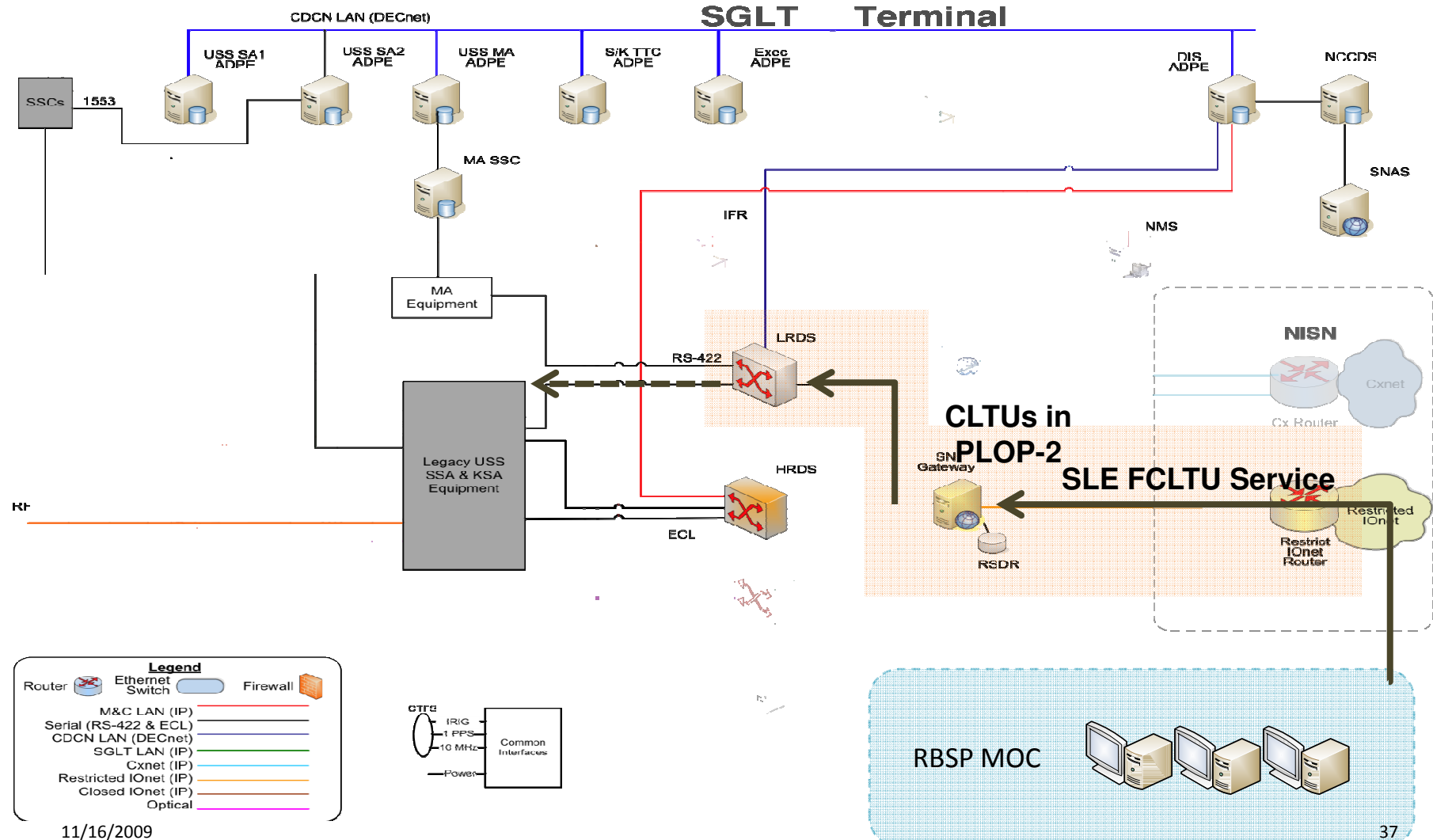
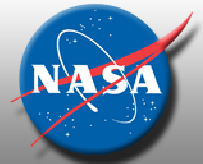
# RBSP Data Flow – Forward Link



Architecture diagrams courtesy of Larry Kiser / Perot Systems.



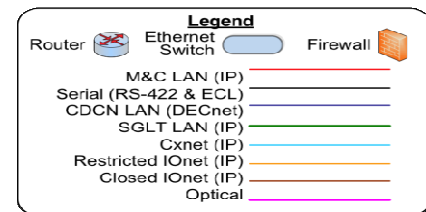
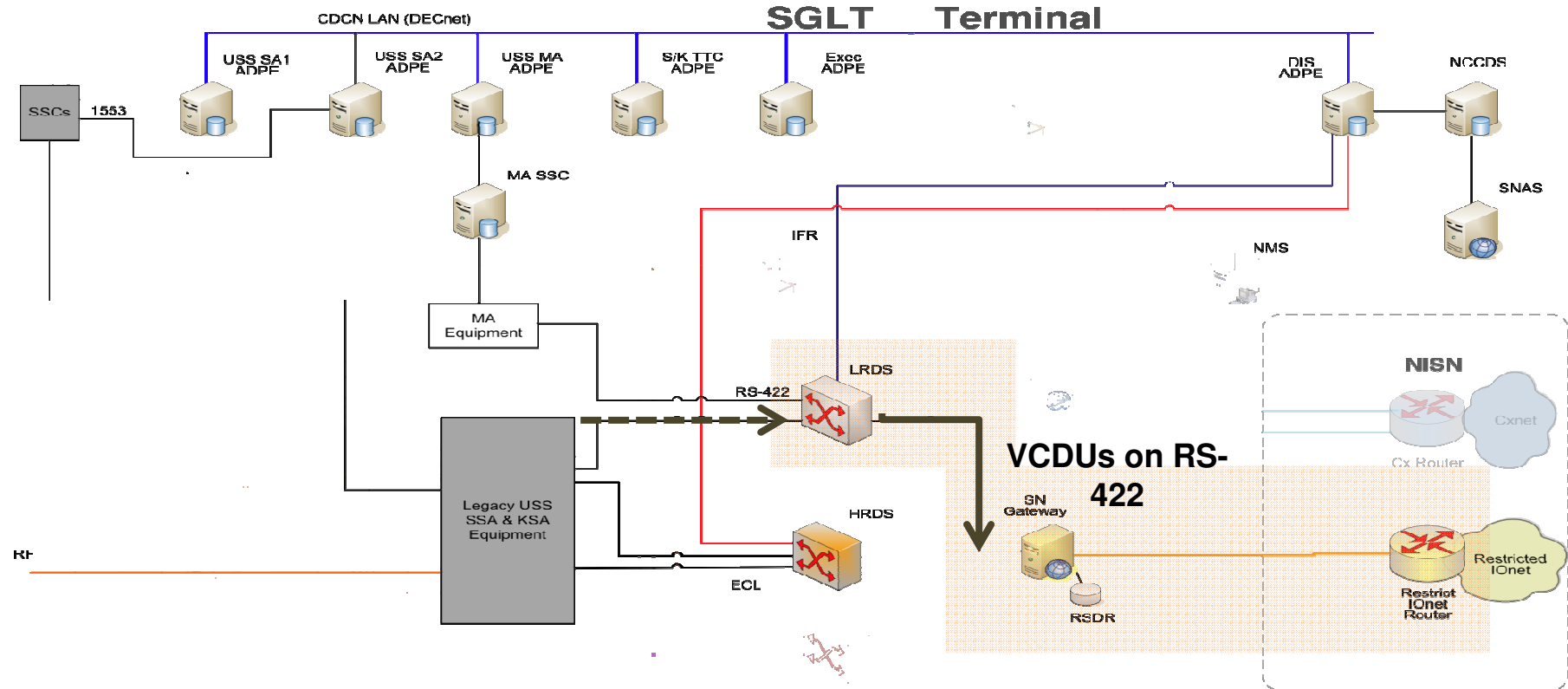
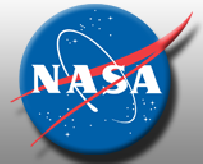
# SNG Context - SN & RBSP FL



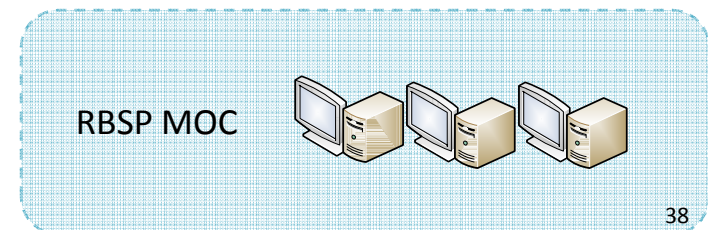
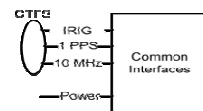
Architecture diagrams courtesy of Larry Kiser / Perot Systems.



# RBSP Data Flow – Return Link



11/16/2009

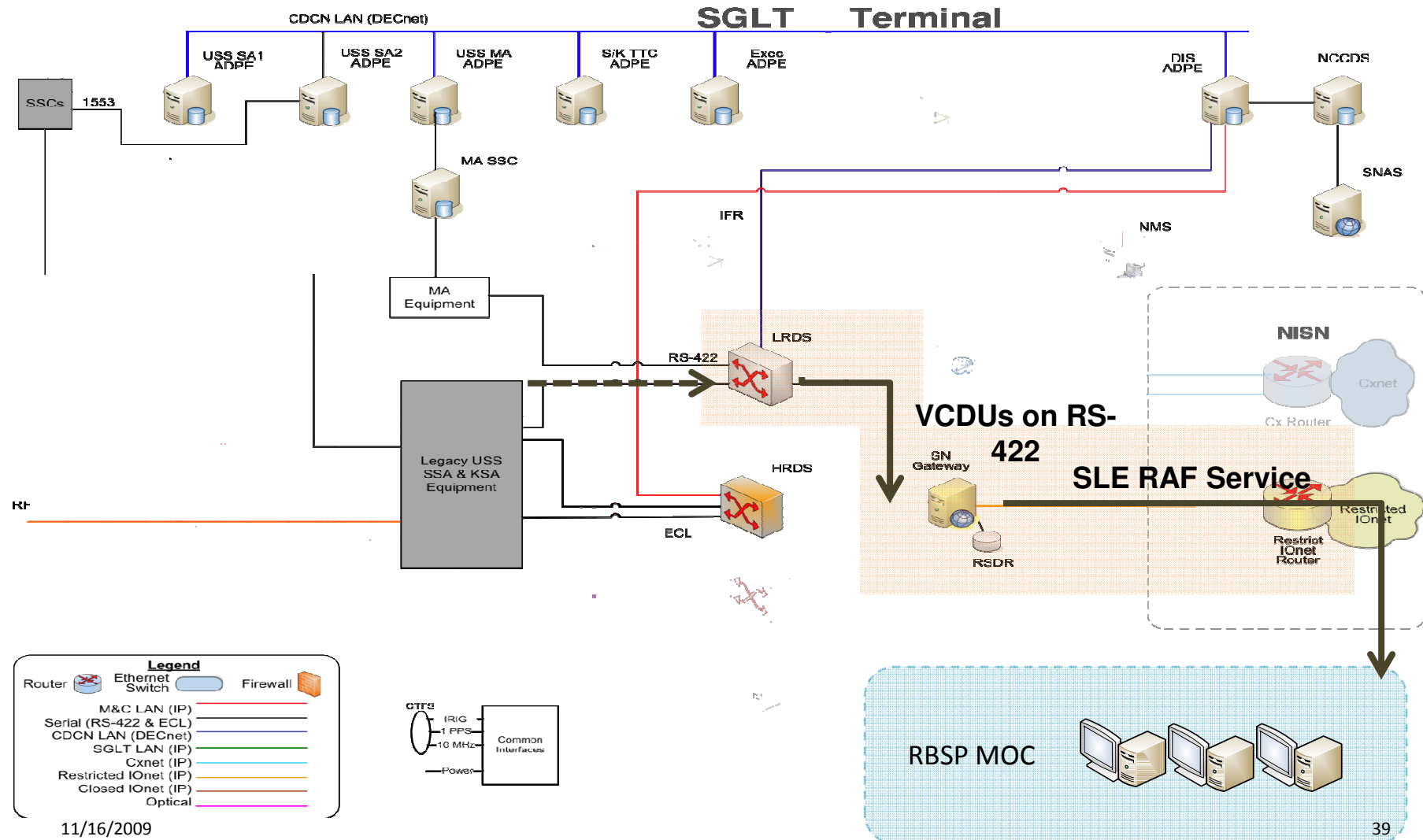


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Architecture diagrams courtesy of Larry Kiser / Perot Systems.



# RBSP Data Flow – Return Link

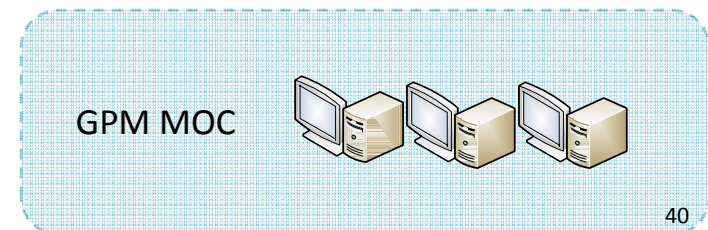
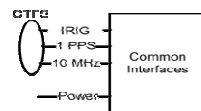
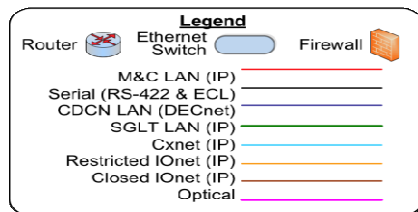
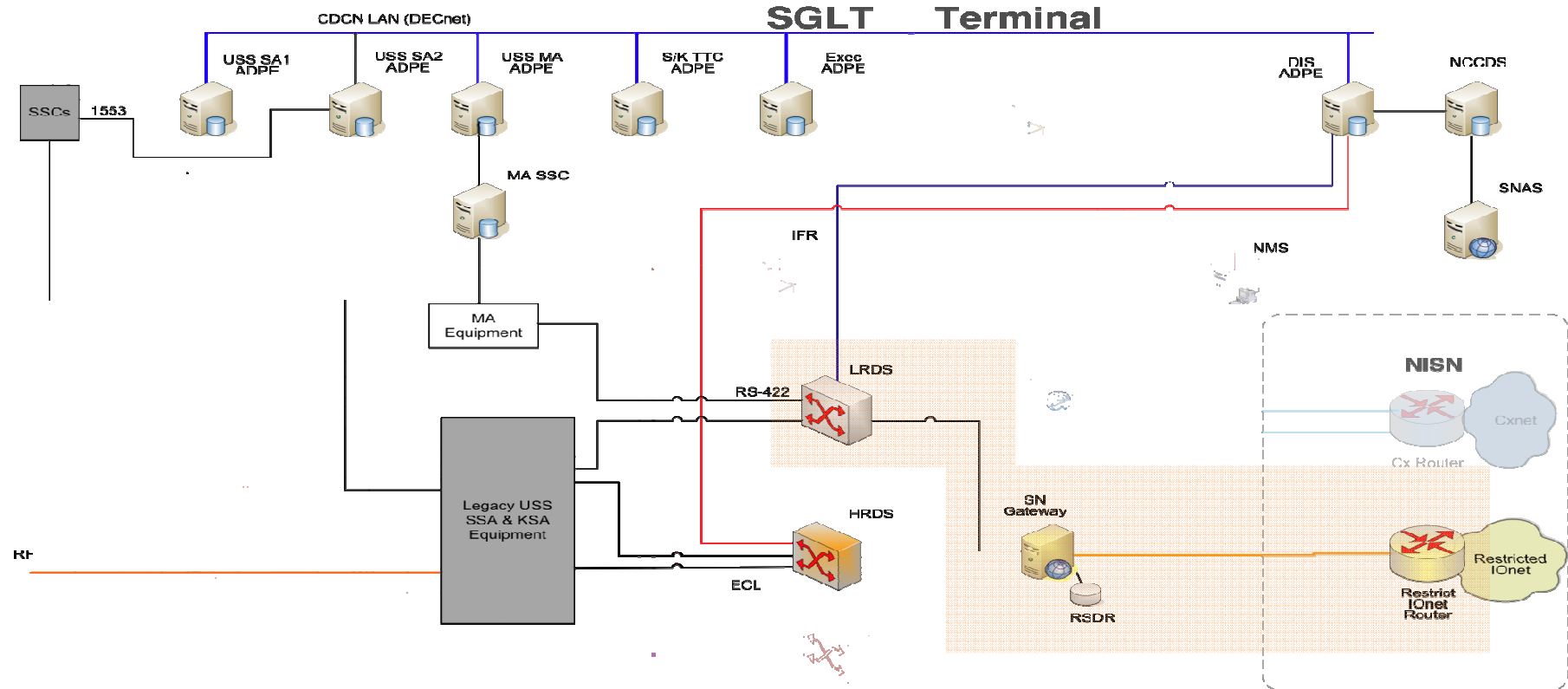
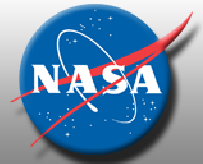


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Architecture diagrams courtesy of Larry Kiser / Perot Systems.



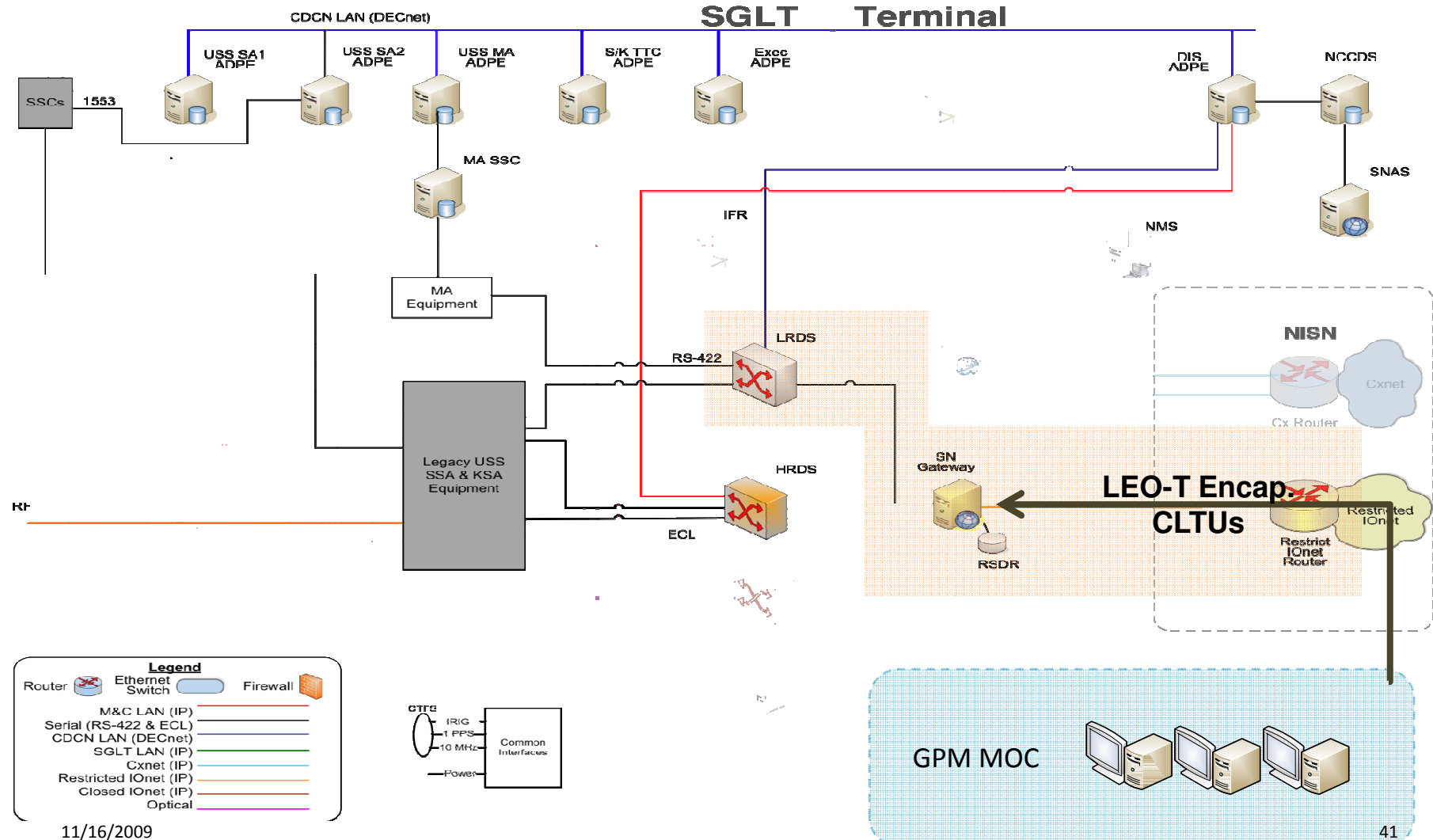
# GPM Data Flow – Forward Link



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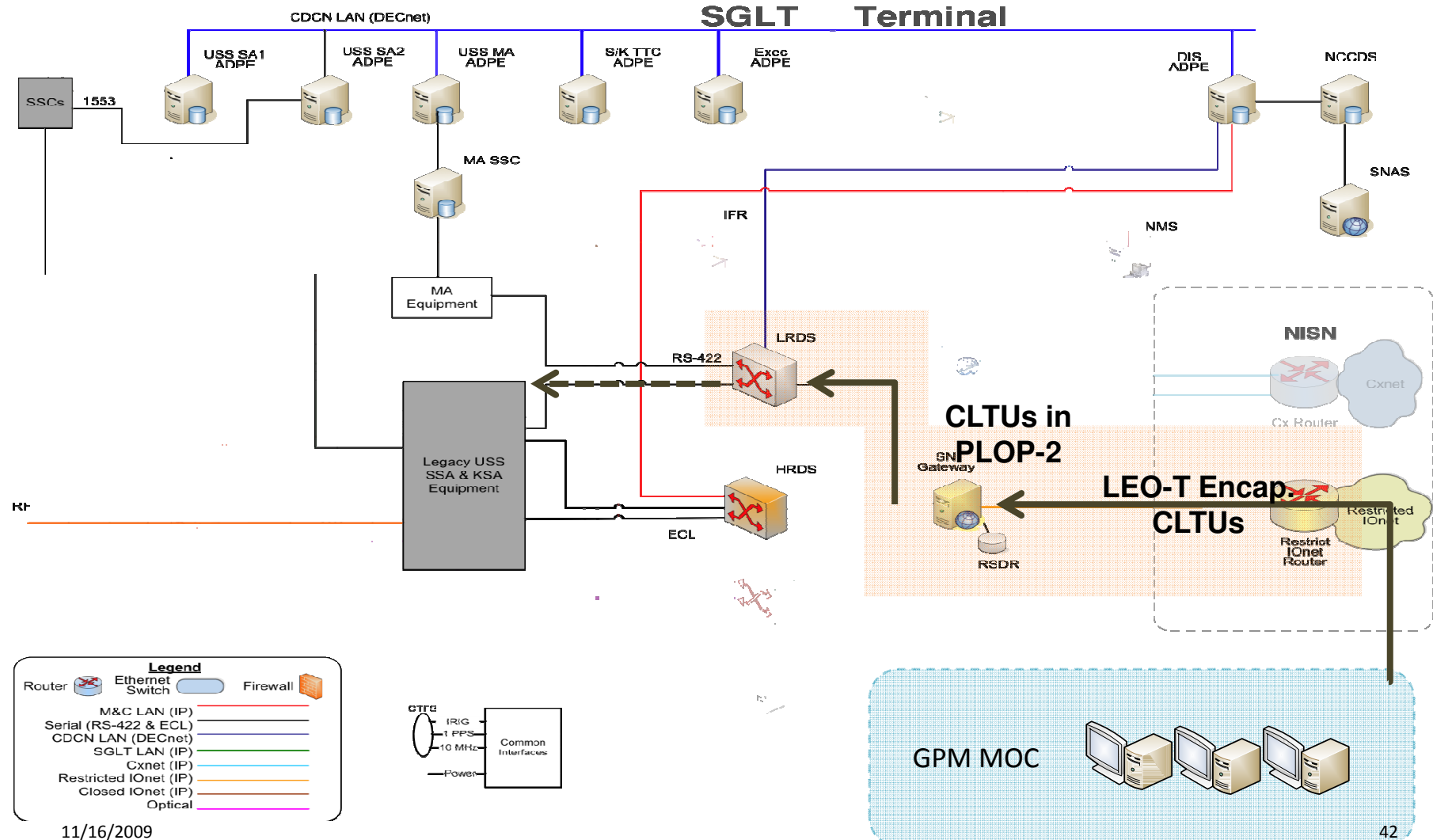
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Architecture diagrams courtesy of Larry Kiser / Perot Systems.



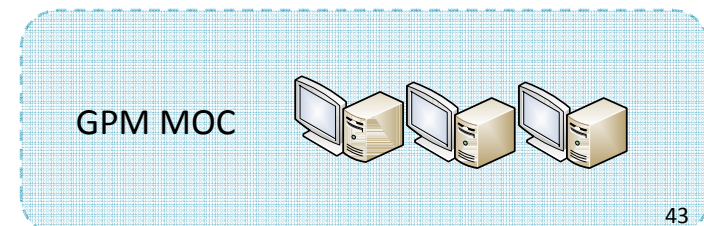
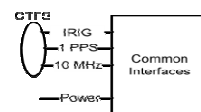
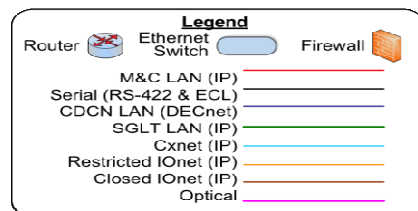
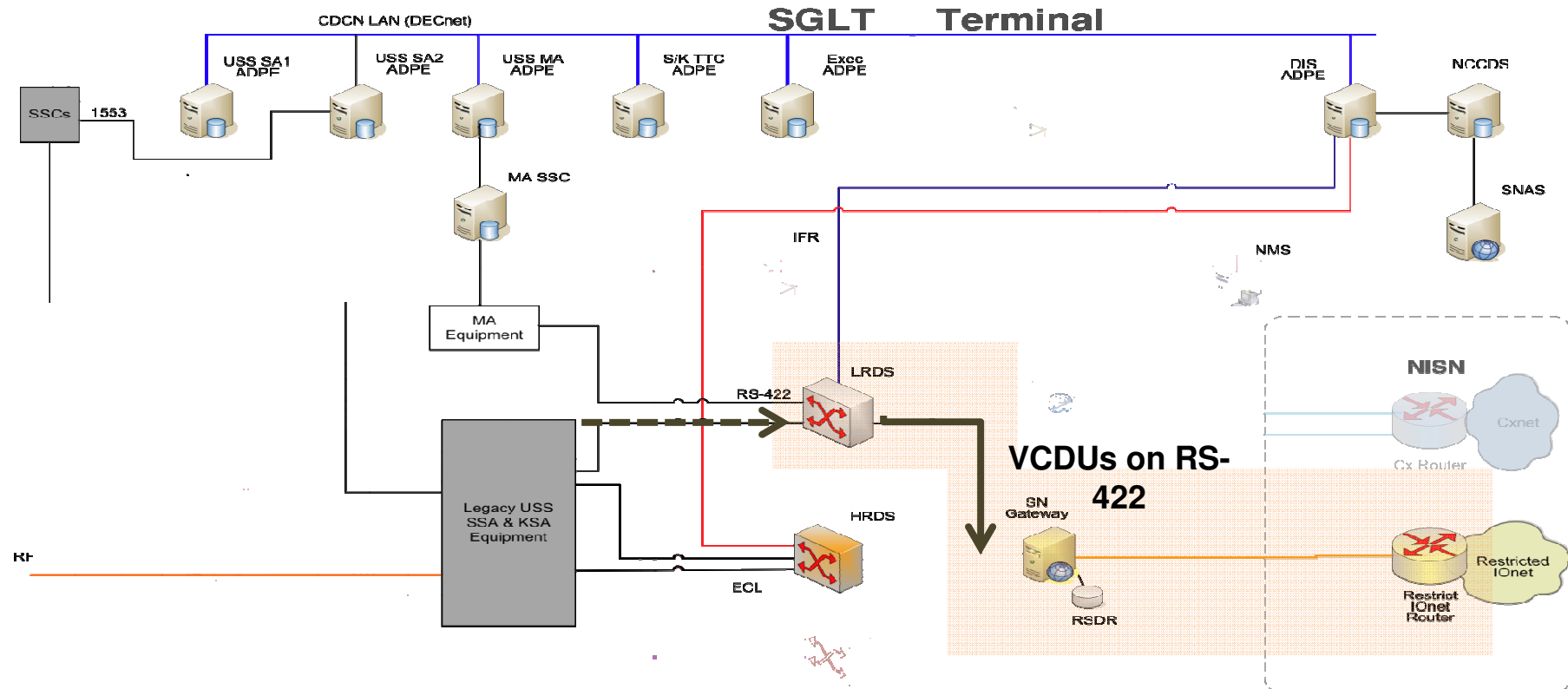


# GPM Data Flow – Forward Link



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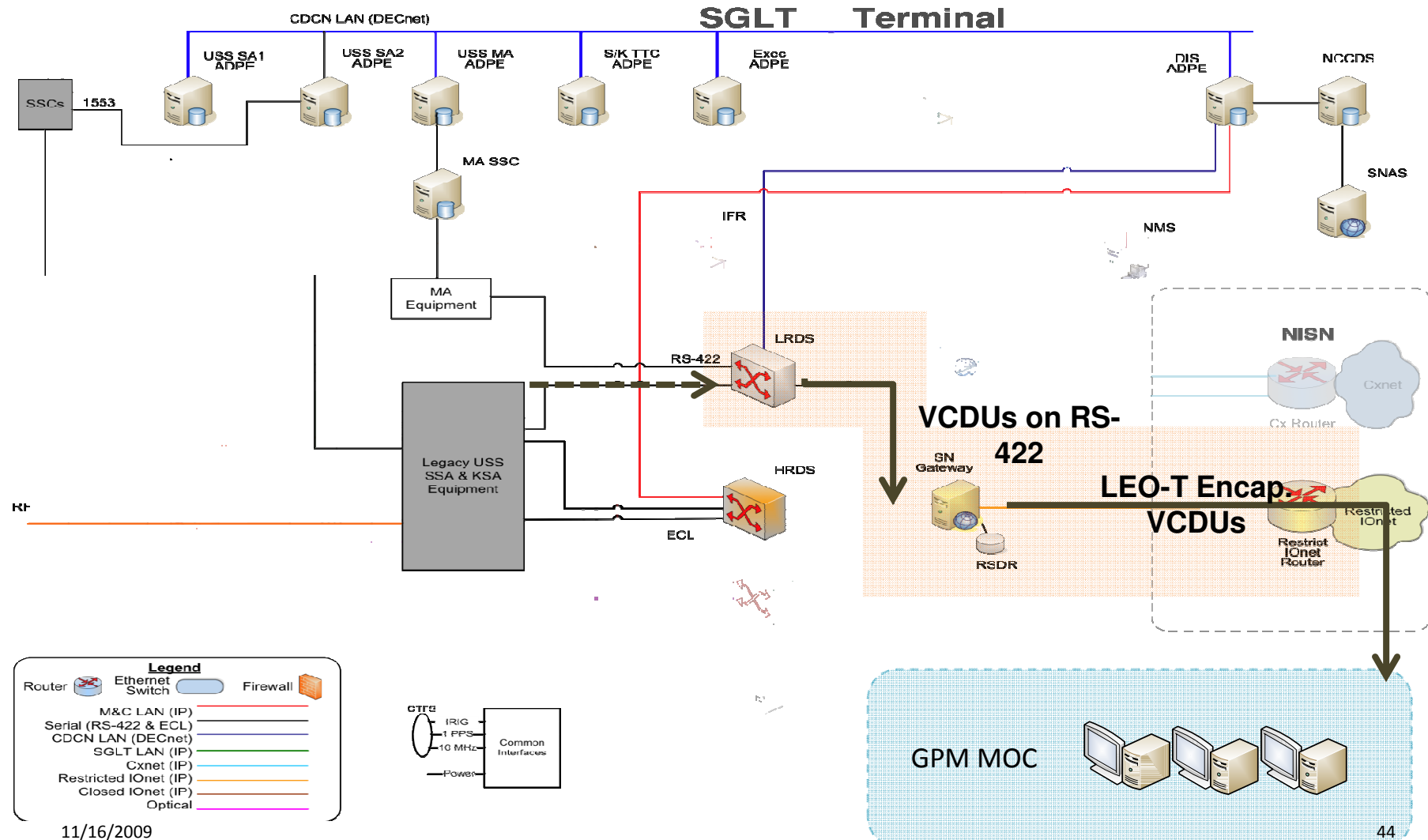
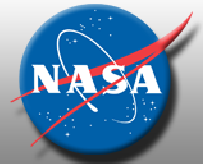
Architecture diagrams courtesy of Larry Kiser / Perot Systems.



11/16/2009

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Architecture diagrams courtesy of Larry Kiser / Perot Systems.



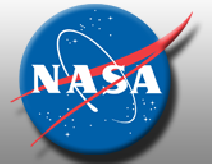


# SNG Deployment Sites



Site	WSC			GSFC
Facility	WSGT	STGT	SMTF	DTTF
SGLTs	3	3	1 simulated	2 simulated
SNGs	2	2	2	2

- GRGT data processed at WSGT
- SNG system counts are provisional



## **Section 3.3**

# **Requirements**



# Requirements Elicitation



- **Discussions with SN, RBSP, GPM**
- **Project Documents**
  - USA SRD and OCD
  - RBSP CONOPS, PLSA
  - GPM Space-to-Ground ICD, RF ICD
  - WDISC CONOPS, System Requirements, Service Specification
- **NASA documents**
- **Industry documents (CCSDS, etc.)**



# Source Documents



Document ID	Title
452-SRD-USA	Space Network User Services Access System Requirements Document
452-OCD-USA	Space Network User Services Access Operations Concept Document
452-SP-USA	Space Network User Services Access Security Plan
450-SNUG	SN User's Guide, Rev. 9
530-RSD-WSC	Requirements Specification Document for the White Sands Complex
NENS-ED-ICD-0028	USA-USSR ICD
CSOC-GSFC-RD-002090	WDISC System Requirements
CSOC-GSFC-OC-002091	WDISC Operations Concept
CSOC-GSFC-RD-002056	WDISC Service Specifications
450-PLSA-RBSP-FY09	RBSP Project Level Service Agreement
7417-9016	RBSP CONOPS
GPM-GSM-REQ-0040	GPM Ground System Requirements Document
GPM-MSE-ICD-0026	GPM Core Space-to-Ground Interface Control Document
450-RFICD-GPM/SN/GN	RF ICD Between GPM Core Observatory and the SN and GN
NPR 2810.1A	NPR Security of Information Technology
530-WSC-0009	WSC Security Manual
700-DOC-029	NISN IONet Security Policy



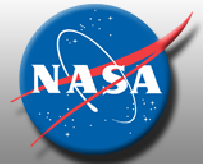
## Source Documents (cont.)



Document ID	Title
47 CFR §15	Federal Communications Commission Title 47 Part 15, 2001
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
RFC 791 (STD 5)	Internet Protocol
RFC 792 (STD 5)	Internet Control Message Protocol
RFC 768 (STD 6)	User Datagram Protocol (UDP)
RFC 793 (STD 7)	Transmission Control Protocol (TCP)
IEEE 802.3	1000BASE-T Gbit/s Ethernet over twisted pair at 1 Gbit/s



## Source Document (cont.)



Doc ID	Date	Title
CCSDS 231.0-B-1	September 2003	Telecommand Synchronization and Channel Coding [Blue Book]
CCSDS 232.0-B-1	September 2003	Telecommand Space Data Link Protocol [Blue Book]
CCSDS 232.1-B-1	September 2003	Command Operations Procedure – 1 [Blue Book]
CCSDS 133.0-B-1	September 2003	CCSDS Space Packet Protocol [Blue Book]
CCSDS 132.0-B-1	September 2003	Telemetry Space Data Link Protocol [Blue Book]
CCSDS 912.1-B-2	November 2004	Space Link Extension Forward CLTU Service Specification [Blue Book]
CCSDS 911.1-B-2	November 2004	Space Link Extension Return All Frames Service Specification [Blue Book]
CCSDS 911.2-B-1	November 2004	Space Link Extension Return Channel Frames Service Specification [Blue Book]
CCSDS 727.0-B-3	June 2005	CCSDS File Delivery Protocol (CFDP) [Blue Book]
CCSDS 131.0-B-1	September 2003	Telemetry Synchronization and Channel Coding [Blue Book]
CCSDS 701.0-B-3	July 2001	Advanced Orbiting Systems, Space Data Link Protocol [Blue Book]
CCSDS 301.0-B-3	January 2002	CCSDS Time Code Formats [Blue Book]
CCSDS 727.0-B-4	January 2007	CCSDS File Delivery Protocol (CFDP) [Blue Book]
CSSDS 915.1-M-1	October 2008	Space Link Extension API for Return All Frames Service [Magenta Book]
CSSDS 915.2-M-1	October 2008	Space Link Extension API for Return Channel Frames Service [Magenta Book]
CSSDS 916.1-M-1	October 2008	Space Link Extension API for Forward CLTU Service [Magenta Book]
CSSDS 913.1-MB1	October 2008	Space Link Extension Internet Protocol for Transfer Services [Blue Book]



# Requirements Management

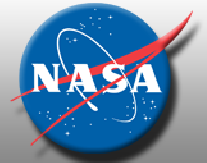


Level 3	<ul style="list-style-type: none"><li>• USA SRD, OCD</li><li>• Customer ICD</li><li>• Architecture Doc</li></ul>	<ul style="list-style-type: none"><li>• System-level documents controlled and provided or approved by NASA or missions</li></ul>
Level 4	<ul style="list-style-type: none"><li>• RTVM</li></ul>	<ul style="list-style-type: none"><li>• Derived from Level 3 and allocated to subsystems</li><li>• Basis for system architecture</li></ul>
Level 5	<ul style="list-style-type: none"><li>• CI Requirements</li></ul>	<ul style="list-style-type: none"><li>• Derived from Level 4 and allocated to individual CIs</li></ul>

- **Level 4 requirement definition work products are subject of SRR**
- **Level 4 requirements baselined at delivery of SNG SRD**
- **Change control begins after requirements are baselined**
  - Assess impact of changes to baseline
  - Define method for approving and implementing



# Requirements Control



- **Requirements IDs consistent with USA schema**
- **Traceability managed within RTVM**
- **Transition of SNG requirements**
  - Level 3 currently in USA SRD
  - Level 3 & 4 baselined in SNG SRD following this SRR



# Key Requirements



- **Have driven the concept because of cost, schedule, or performance**
  - USA
    - $\geq 2$  concurrent forward links @ 125 bps – 5 Mbps
    - $\geq 4$  concurrent return links @ 1 kbps – 5 Mbps
  - RBSP
    - SLE FCLTU and RAF, connections initiated by MOC
    - Nominal 125 bps forward and 1 kbps return
  - GPM
    - LEO-T encapsulation, connections initiated by SNG
    - Nominal 64 kbps forward and 2.3 Mbps return
  - Security
    - Comply with updated SN Security Plan and IONet Security Policy
    - Working with all parties to develop security requirements consistent with SNG design



# Key Requirements - Security



- **All SN Gateway security requirements provided in:**
  - 700-DOC-29: NISN IONet Security Policy
  - WSC-PLN-0088: Mission Essential Infrastructure (MEI) Systems IT Security Plan
- **Both documents being revised in Spring 2010**
- **FISMA/NIST and NPR 2810.1A requirements are addressed by these documents:**
  - SN network is assessed as a High System
  - NIST 800-53 controls is being updated to revision 3
  - WSC-PLN-0088 will address all revision 3 NIST 800-53 controls



# Inherent Reliability & Availability



- **USA System Inherent Reliability**

USA SRD	Requirement Area	Requirement
¶ 5.3a	USA System Availability ( $A_i$ )	0.9998
¶ 5.2.1	MTBF	2,500 hours
¶ 5.2.1a	MTTR	0.5 hours

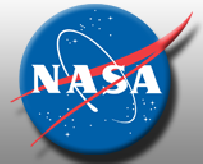
- **SN Gateway Inherent Reliability**

- To meet USA requirements, SN Gateway assumed to have  $\geq 10 \times$  USA  $A_i$

SNG SRD	Requirement Area	Requirement
	SNG System Availability ( $A_i$ )	0.99998
¶ 4.6.8	MTBF	$\geq 25,000$ hours
¶ 4.6.9	MTTR	0.5 hours



# Operational Reliability & Availability



- **USA System Operational Reliability**

USA SRD	Requirement Area	Requirement
¶ 5.4c	USA System Availability ( $A_o$ )	0.9999
¶ 5.2.1	MTBF Affecting Service	10,000 hours
¶ 5.2.1	MTTR Service Unavailable	0.5 hours

- **SN Gateway Operational Reliability**

- To meet USA requirements, SN Gateway assumed to have  $\geq 10 \times$  USA  $A_o$

SNG SRD	Requirement Area	Requirement
	SNG System Availability ( $A_o$ )	0.99999
¶ 4.6.8	MTBF Affecting Service	$\geq 50,000$ hours
¶ 4.6.9	MTTR Service Unavailable	0.5 hours



# Environmental Specifications



- **SNG is in a climate controlled environment**
- **Several relevant specifications evaluated**
  - NASA-STD-5005C: Standard for the Design and Fabrication of Ground Support Equipment (13 March 2009)
  - HRDSS Requirements Specification Document: New HRDS Procurement Specification (27 August 2007)
  - ANSI/SCTE 158 2009: Recommended Environmental Condition Ranges for Broadband Communications Equipment (2009)
    - Class 2 = Head-end equipment (e.g. modulators, receivers, demodulators)
    - Class 3A = Indoor customer premise equipment



# Environmental Specification Recommendations



- **ANSI/SCTE 158 2009 Class 3A for indoor customer premise equipment environmental requirements for operating and non-operating environments**

- Temperature
- Humidity
- Shock & Vibration
- Altitude

Environment	Requirements
Operating	5 – 20 Hz @ 0.25" (6.4mm) Displacement 20 – 350 Hz @ 0.05G's Peak
Storage	10 – 30 – 10 Hz, minimum of 6 sweeps @ 0.039" (1.0 mm) Displacement
Shipping in Packaging	International Safe Transit Association (ISTA) Test Procedure 1A 2.5 – 5 Hz @ 1" (25.4 mm) Displacement

- **FCC Part 15 Subpart B – Unintentional Radiators**
  - EMI/EMC



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
1	SNG-FG-01	4.1.1.1.	All SNG functions shall be individually and selectively configurable.	452-SRD-USA 4.4.1a	
2	SNG-FG-02	4.1.1.2.	The SNG shall have a client/server relationship with the Customer MOC.	452-SRD-USA 4.4.1v	
3	SNG-FG-03	4.1.1.3.	The SNG shall act as either the client or the server in the client/server relationship.	452-SRD-USA 4.4.1w	<b>SNG-FG-03.01</b> <b>SNG-FG-03.02</b> <b>SNG-FG-03.03</b>
4	SNG-FG-03.01	4.1.1.4.	The SNG shall be capable of acting as a client in the client/server relationship.	<b>SNG-FG-03</b>	
5	SNG-FG-03.02	4.1.1.5.	The SNG shall be capable of acting as a server in the client/server relationship.	<b>SNG-FG-03</b>	
6	SNG-FG-03.03	4.1.1.6.	The SNG shall be capable of acting as a client and a server in separate simultaneous relationships.	<b>SNG-FG-03</b>	
7	SNG-FG-04	4.1.1.7.	All controls and displays shall be fully accessible during setup and normal operation of the SNG.	452-SRD-USA 7.1.c	<b>SNG-FG-04.01</b> <b>SNG-FG-04.02</b>
8	SNG-FG-04.01	4.1.1.8.	The SNG shall provide local control and status functions to authorized WSC Operators.	<b>SNG-FG-04</b>	
9	SNG-FG-04.02	4.1.1.9.	The SNG shall provide remote control and status functions to authorized WSC Operators.	<b>SNG-FG-04</b>	
10	SNG-FG-05	4.1.1.10.	The SNG shall provide alerts to notify Operators of configuration changes caused by other users of the SNG.	MSES-2A-RPT-0367-0002(-) 4.1.1.10	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
11	SNG-FG-06	4.1.1.11.	The SNG shall provide the physical layer performance parameters including frame sync lock status and (if applicable) the Reed-Solomon FEC performance.	MSES-2A-RPT-0367-0002(-) 4.1.1.11	
12	SNG-FG-07	4.1.1.12.	The SNG shall support simultaneous forward and return links for both RBSP and GPM.	452-SRD-USA 4.4.3.q	
13	SNG-FG-08	4.1.1.13.	The SNG shall not interfere with existing WSC equipment during any phase of its lifecycle.	452-SRD-USA 4.1.1.q	
14	SNG-FG-09	4.1.1.14.	The SNG shall support functional or interface expansion.	452-SRD-USA 4.1.3.a 452-SRD-USA 4.1.3.b	
15	SNG-FF-01	4.1.2.1.	The SNG shall implement the subset of TDRSS SSA Forward (SSAF) data services required to support RBSP and GPM.	452-SRD-USA 4.1.1.e	<b>SNG-FF-01.01</b> <b>SNG-FF-01.02</b>
16	SNG-FF-01.01	4.1.2.2.	The SNG shall implement CCSDS PLOP-2 as part of COP-1 processing performed by the RBSP and GPM MOCs.	<b>SNG-FF-01</b>	
17	SNG-FF-01.02	4.1.2.3.	The SNG shall forward the CLCW as a trailer field in the mission real-time telemetry frame.	<b>SNG-FF-01</b>	
18	SNG-FF-02	4.1.2.4.	The SNG shall support a minimum of two (2) simultaneous forward data channels.	452-SRD-USA 4.4.1k	
19	SNG-FF-03	4.1.2.5.	The SNG shall implement the SLE Forward Command Link Transmission Unit (FCLTU) service per CCSDS Recommendation 912.2-B-2: Space Link Extension - Forward CLTU Service Specification.	452-SRD-USA 4.4.1.o	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
20	SNG-FF-04	4.1.2.6.	The SNG SLE FCLTU Service shall comply with the CCSDS 916.1-M-0.1 Space Link Extension - Application Program Interface for the Forward CLTU Service.	452-SRD-USA 4.4.1.p	
21	SNG-FF-05	4.1.2.7.	The SNG shall act as an SLE Provider for the FCLTU Service.	MSES-2A-RPT-0367-0002(-) 4.1.2.7	
22	SNG-FF-06	4.1.2.8.	The SNG shall store previously defined and tested forward data channel processing specifications based on the forward service schedule parameters specified in 452-OCD-USA, Space Network User Service Access Operations Concept Document.	452-SRD-USA 4.4.2.a	<b>SNG-FF-06.01</b>
23	SNG-FF-06.01	4.1.2.9.	A stored forward data channel processing specification shall be loaded no less than 120 seconds prior to activation.	<b>SNG-FF-06</b>	
24	SNG-FF-07	4.1.2.10.	A forward data channel processing specification shall be activated no less than 20 seconds prior to the scheduled service start time.	452-SRD-USA 4.4.2.b	<b>SNG-FF-07.01</b>
25	SNG-FF-07.01	4.1.2.11.	The SNG shall support manual activation of a forward data processing specification.	<b>SNG-FF-07</b>	
26	SNG-FF-08	4.1.2.12.	If indicated by the active forward service data channel processing specification, the SNG shall establish a TCP/IP connection with the Customer MOC prior to the scheduled service start time.	452-SRD-USA 4.4.2.c	<b>SNG-FF-08.01</b>



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
27	SNG-FF-08.01	4.1.2.13.	If the TCP/IP connection is not established successfully, the SNG shall record this fact and return to a state in which it is again ready to establish a connection.	<b>SNG-FF-08</b>	
28	SNG-FF-09	4.1.2.14.	The SNG shall be capable of receiving forward service SLE PDUs from the Restricted IONet router.	452-SRD-USA 4.4.2.d	
29	SNG-FF-10	4.1.2.15.	The SNG shall be capable of receiving forward service LEO-T SFDUs from the Restricted IONet router.	452-SRD-USA 4.4.2.d	
30	SNG-FF-11	4.1.2.16.	If indicated by the active forward service data channel processing specification, the SNG shall transmit the forward service data using the SLE FCLTU service.	452-SRD-USA 4.4.2.e	
31	SNG-FF-12	4.1.2.17.	If indicated by the active forward service data channel processing specification, the SNG shall perform idle pattern generation as specified in the CCSDS 231.0.B-1, TC Synchronization and Channel Coding.	452-SRD-USA 4.4.2.i	<b>SNG-FF-12.01</b>
32	SNG-FF-12.01	4.1.2.18.	The SNG shall be configurable to generate idle patterns explicitly beginning with a 0 or a 1.	<b>SNG-FF-12</b>	
33	SNG-FF-13	4.1.2.19.	If indicated by the active forward service data channel processing specification, the SNG shall perform Grade 2 Reed-Solomon encoding on the forward data stream as defined in the CCSDS 732.0-B-2, AOS Space Data Link Protocol.	452-SRD-USA 4.4.2.k	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
34	SNG-FF-14	4.1.2.20.	If indicated by the active forward service data channel processing specification, the SNG shall perform randomization on the forward data stream as defined in CCSDS 131.0-B-1 TM Synchronization and Channel Coding.	452-SRD-USA 4.4.2.n	
35	SNG-FF-15	4.1.2.21.	If indicated by the active forward service data channel processing specification, the SNG shall perform synchronization marker attachment on the forward data stream as defined in CCSDS 131.0-B-1 TM Synchronization and Channel Coding.	452-SRD-USA 4.4.2.o	<b>SNG-FF-15.01</b>
36	SNG-FF-15.01	4.1.2.22.	The SNG shall be capable of attaching a 32-bit ASM if specified.	<b>SNG-FF-15</b>	
37	SNG-FF-16	4.1.2.23.	If indicated by the active forward service data channel processing specification, the SNG shall perform rate 1/2 convolutional encoding on the forward data stream as defined in 450-SNUG.	452-SRD-USA 4.4.2.p	
38	SNG-FF-17	4.1.2.24.	The SNG shall present the forward service data that have been processed according to the forward data channel processing specification to the USS/USSR as a synchronous serial bit stream.	452-SRD-USA 4.4.2.q	
39	SNG-FR-01	4.1.3.1.	The SNG shall support SSAR DG1 single data source.	452-SRD-USA 4.1.1.f	
40	SNG-FR-02	4.1.3.2.	The SNG shall support SSAR DG2 dual-channel QPSK.	MSES-2A-RPT-0367-0002(-) 4.1.3.2	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
41	SNG-FR-03	4.1.3.3.	The SNG shall support physically separate I&Q serial input channels.	MSES-2A-RPT-0367-0002(-) 4.1.3.3	
42	SNG-FR-04	4.1.3.4.	The SNG shall distribute GPM telemetry frames to the MOC as LEO-T SFDUs in IP packets.	MSES-2A-RPT-0367-0002(-) 4.1.3.4	<b>SNG-FR-04.01</b>
43	SNG-FR-04.01	4.1.3.5.	The SNG shall distribute GPM I&Q telemetry frames to the MOC on two separate IP sockets on a single Ethernet connection.	<b>SNG-FR-04</b>	
44	SNG-FR-05	4.1.3.6.	The SNG shall support a minimum of four (4) simultaneous return data channels.	452-SRD-USA 4.4.1.k	
45	SNG-FR-06	4.1.3.7.	The SNG shall implement the SLE Return All Frames (RAF) Service per CCSDS Recommendation 911.1-B-2: Space Link Extension - Return All Frames Service Specification.	452-SRD-USA 4.4.1.q	
46	SNG-FR-07	4.1.3.8.	The SNG SLE RAF service shall comply with the CCSDS 915.1-M-0.1 Space Link Extension - Application Program Interface for the Return All Frames Service.	452-SRD-USA 4.4.1.r	
47	SNG-FR-08	4.1.3.9.	The SNG shall implement the SLE Return Channel Frames (RCF) Service per CCSDS Recommendation 911.2-B-1: Space Link Extension - Return Channel Frames Service Specification.	452-SRD-USA 4.4.1.s	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
48	SNG-FR-09	4.1.3.10.	The SNG SLE RCF service shall comply with the CCSDS 915.2-M-0.1 Space Link Extension - Application Program Interface for the Return Channel Frame Service.	452-SRD-USA 4.4.1.t	
49	SNG-FR-10	4.1.3.11.	The SNG shall act as an SLE Provider for the RAF and RCF Services.	MSES-2A-RPT-0367-0002(-) 4.1.3.11	
50	SNG-FR-11	4.1.3.12.	The SNG shall support SLE Complete Online Delivery mode.	452-SRD-USA 4.4.3.o	
51	SNG-FR-12	4.1.3.13.	The SNG shall support Offline Delivery via SFTP.	MSES-2A-RPT-0367-0002(-) 4.1.3.13	
52	SNG-FR-13	4.1.3.14.	The SNG shall store previously defined and tested return data channel processing specifications based on the return service schedule parameters specified in 452-OCD-USA, Space Network User Service Access Operations Concept Document.	452-SRD-USA 4.4.3.a	<b>SNG-FR-13.01</b>
53	SNG-FR-13.01	4.1.3.15.	A stored return data channel processing specification shall be loaded no less than 120 seconds prior to activation.	<b>SNG-FR-13</b>	
54	SNG-FR-14	4.1.3.16.	A return data channel processing specification shall be activated no less than 20 seconds prior to the scheduled service start time.	452-SRD-USA 4.4.3.b	<b>SNG-FR-14.01</b>
55	SNG-FR-14.01	4.1.3.17.	The SNG shall support manual activation of a return data processing specification.	<b>SNG-FR-14</b>	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
56	SNG-FR-15	4.1.3.18.	If indicated by the active return service data channel processing specification, the SNG shall establish a TCP/IP connection with the Customer MOC prior to the scheduled service start time.	452-SRD-USA 4.4.3.c	<b>SNG-FR-15.01</b> <b>SNG-FR-15.02</b>
57	SNG-FR-15.01	4.1.3.19.	If the TCP/IP connection is not established successfully, the SNG shall log this fact and return to a state in which it is again ready to establish a connection.	<b>SNG-FR-15</b>	
58	SNG-FR-15.02	4.1.3.20.	If the TCP/IP connection is not established successfully, the SNG shall continue to process return data as usual and record it for future Offline delivery.	<b>SNG-FR-15</b>	
59	SNG-FR-16	4.1.3.21.	The SNG shall receive return service data from the USS/USSR as a synchronous serial bit stream.	452-SRD-USA 4.4.3.d	
60	SNG-FR-17	4.1.3.22.	The SNG shall use the synchronization marker specified in the return service data channel processing specification to extract the return service data frames.	452-SRD-USA 4.4.3.e	<b>SNG-FR-17.01</b>
61	SNG-FR-17.01	4.1.3.23.	The SNG shall support configurable CCSDS ASMs up to 32 bits on return data.	<b>SNG-FR-17</b>	
62	SNG-FR-18	4.1.3.24.	If indicated by the active return service data channel processing specification, the SNG shall time tag each incoming data frame with SNG Receipt Time at which the most significant bit (MSB) of the frame entered the frame synchronizer of the SNG.	452-SRD-USA 4.4.3.f	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
63	SNG-FR-19	4.1.3.25.	If indicated by the active return service data channel processing specification, the SNG shall perform de-randomization on the return data stream as defined in CCSDS 131.0-B-1 TM Synchronization and Channel Coding.	452-SRD-USA 4.4.3.g	
64	SNG-FR-20	4.1.3.26.	If indicated by the active return service data channel processing specification, the SNG shall perform Grade 2 Reed-Solomon decoding on the return data stream as defined in CCSDS 131.0-B-1 TM Synchronization and Channel Coding.	452-SRD-USA 4.4.3.h	
65	SNG-FR-21	4.1.3.27.	The SNG shall be capable of performing raw serial recording of all concurrent active return data services.	452-SRD-USA 4.4.3.r	<b>SNG-FR-21.01</b> <b>SNG-FR-21.02</b>
66	SNG-FR-21.01	4.1.3.28.	The SNG shall record the return service raw serial data in terms of uniquely identifiable, time tagged data files.	<b>SNG-FR-21</b> <b>452-SRD-USA 4.4.3.t</b> <b>452-SRD-USA 4.4.3.z</b>	
67	SNG-FR-21.02	4.1.3.29.	The SNG shall record raw serial data for an active return data service in a single unique file not shared with other active services.	SNG-FR-21	
68	SNG-FR-22	4.1.3.30.	Upon request from a Customer MOC, the SNG shall forward the requesting Customer's recorded return service raw data files to the MOC either automatically using SFTP or manually through WSC operator intervention.	452-SRD-USA 4.4.3.bb	<b>SNG-FR-22.01</b>



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
69	SNG-FR-22.01	4.1.3.31.	The SNG shall be capable of forwarding raw service recordings upon manual operator command.	<b>SNG-FR-22</b>	
70	SNG-FR-23	4.1.3.32.	The SNG shall be capable of recording synchronized frames for all concurrent active none-SLE return data services.		<b>SNG-FR-23.01</b> <b>SNG-FR-23.02</b>
71	SNG-FR-23.01	4.1.3.33.	The SNG shall record the frame synchronized return service data in terms of uniquely identifiable, time tagged data files.	<b>SNG-FR-23</b>	
72	SNG-FR-23.02	4.1.3.34.	The SNG shall record the frame synchronized return service data for an active return data service in a single unique file not shared with other active services.	<b>SNG-FR-23</b>	
73	SNG-FR-24	4.1.3.35.	Upon request from a Customer MOC, the SNG shall forward the requesting Customer's recorded frame synchronized return service data files to the MOC either automatically using SFTP or manually through WSC operator intervention.		<b>SNG-FR-24.01</b>
74	SNG-FR-24.01	4.1.3.36.	The SNG shall be capable of forwarding the frame synchronized return service data recordings upon manual operator command.	<b>SNG-24</b>	
75	SNG-FR-25	4.1.3.37.	The SNG shall maintain the SLE RAF/RCF offline frame buffer in local storage.	452-SRD-USA 4.4.3.x	<b>SNG-FR-25.01</b> <b>SNG-FR-25.02</b>
76	SNG-FR-25.01	4.1.3.38.	The SNG shall record SLE SDU data for an active return data service in a single unique file not shared with other active services.	<b>SNG-FR-25</b>	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
84	SNG-PG-02	4.2.1.3.	The SNG shall deliver an average bit error probability less than one error in $10^{13}$ bits over any 24-hour test interval at any data rate on a digital connection through the Data Interface System (DIS), including the Guam Data Interface System (GDIS) but excluding the common carrier portion of the GDIS, between the input from the Legacy USS Equipment and output to the NISN IONet router interface and vice versa.	452-SRD-USA 4.1.2.d	
85	SNG-PG-03	4.2.1.4.	The SNG shall support activation of a loaded forward or return data channel processing specification in less than 15 seconds. Configuration loading is performed by an operator and is not required to complete within a specific time limit.	452-SRD-USA 4.1.2.h	
86	SNG-PG-04	4.2.1.5.	The SNG shall provide updated status information to local and remote Operators at intervals no greater than 5 seconds.	452-SRD-USA 4.4.4.d	
87	SNG-PF-01	4.2.2.1.	The SNG shall support Forward service data rates down to 125 bps.	MSES-2A-RPT-0367-0002(-) 4.2.2.1	
88	SNG-PF-02	4.2.2.2.	The SNG shall support Forward service data rates up to 5 Mbps.	452-SRD-USA 4.4.4.a	
89	SNG-PF-03	4.2.2.3.	All SNG forward data channels shall be capable of operating simultaneously at up to 5 Mbps.	MSES-2A-RPT-0367-0002(-) 4.2.2.3	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
90	SNG-PR-01	4.2.3.1.	The SNG shall support Return service data rates down to 1 kbps.	MSES-2A-RPT-0367-0002(-) 4.2.3.1	
91	SNG-PR-02	4.2.3.2.	The SNG shall support Return service data rates up to 5 Mbps.	452-SRD-USA 4.4.4.b	
92	SNG-PR-03	4.2.3.3.	All SNG return data channels shall be capable of operating simultaneously at up to 5 Mbps.	MSES-2A-RPT-0367-0002(-) 4.2.3.3	
93	SNG-PR-04	4.2.3.4.	The SNG shall be capable of time tagging return service data frames with 100 microsecond accuracy.	MSES-2A-RPT-0367-0002(-) 4.2.3.4	
94	SNG-PR-05	4.2.3.5.	The SNG shall be capable of retaining each return service raw data file for a minimum of 30 days.	452-SRD-USA 4.4.3.u 452-SRD-USA 4.4.3.aa	<b>SNG-PR-05.01</b>
95	SNG-PR-05.01	4.2.3.6.	The SNG shall be capable of removing raw data recordings prior to 30 days upon operator command.	<b>SNG-PR-05</b>	
96	SNG-PR-06	4.2.3.7.	The SNG shall be capable of retaining return service SLE SDUs of each SLE instance in an offline frame buffer for a minimum of 30 days.	452-SRD-USA 4.4.3.y	<b>SNG-PR-06.01</b>
97	SNG-PR-06.01	4.2.3.8.	The SNG shall be capable of removing stored SLE SDU offline buffers prior to 30 days upon operator command.	<b>SNG-PR-06</b>	
98	SNG-IFC-01	4.3.1.	The SNG shall provide an IEEE 802.3-compliant Gigabit Ethernet network interface to the NISN Restricted IONet.	452-SRD-USA 4.4.1.h	
99	SNG-IFC-02	4.3.2.	The SNG shall connect to the RBSP and GPM MOCs via the Restricted IONet.	MSES-2A-RPT-0367-0002(-) 4.3.2	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
100	SNG-IFC-03	4.3.3.	The SNG shall connect to Legacy USS Equipment via RS-422 forward and return interfaces to the LRDS.	MSES-2A-RPT-0367-0002(-) 4.3.3	
101	SNG-IFC-04	4.3.4.	The SNG shall use the Common Time and Frequency Subsystem (CTFS) for all SNG functions that require time and frequency referencing.	452-SRD-USA 4.1.1.k	<b>SNG-IFC-04.01</b> <b>SNG-IFC-04.02</b> <b>SNG-IFC-04.03</b>
102	SNG-IFC-04.01	4.3.5.	The SNG shall support IRIG-B signal input.	<b>SNG-IFC-04</b>	
103	SNG-IFC-04.02	4.3.6.	The SNG <b>should</b> support IRIG-G signal input.	<b>SNG-IFC-04</b>	
104	SNG-IFC-04.03	4.3.7.	The SNG shall support 10Mhz External Reference signal input.	<b>SNG-IFC-04</b>	
105	SNG-IFC-05	4.3.8.	The SNG shall use Coordinated Universal Time (UTC) for all parameters containing a time value.	452-SRD-USA 4.1.1.l	
106	SNG-IFC-06	4.3.9.	The SNG shall support the Internet Protocol Version 4 (IPv4) per RFC 791.	452-SRD-USA 4.1.1.m	
107	SNG-IFC-07	4.3.10.	The SNG shall successfully operate using the power available within the SN facility, thus not requiring either a quantity or quality of electric power that exceeds the capabilities of the SN facility.	452-SRD-USA 4.1.1.v	
108	SNG-SEC-01	4.4.1.	The SNG shall comply with the SN Security Plan (composed of NENS-PMO-PLAN-0123 and SSP SO-001-H-GSF-4012).	452-SRD-USA 5.2.1.b	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
109	SNG-SEC-02	4.4.2.	The SNG shall adhere to the security requirements specified in the 700-DOC-029, NASA Integrated Services Network (NISN) Internet Protocol Operational Network (IONet) Security Policy, Section 3 IONet Policies and Security Requirements.	452-SRD-USA 6.1.c	
110	SNG-SEC-03	4.4.3.	The SNG shall implement access control based on the identity of the initiator and the responder. The roles of initiator and responder are played by both the SNG and the Customer MOC.	452-SRD-USA 4.4.1.x	
111	SNG-SEC-04	4.4.4.	When acting as the server, the SNG shall implement authentication for data transfer services invoked by the clients.	452-SRD-USA 4.4.1.y	
112	SNG-SEC-05	4.4.5.	The SNG shall support the SLE None, Bind, and All authentication levels.	MSES-2A-RPT-0367-0002(-) 4.4.5	<b>SNG-SEC-05.01</b> <b>SNG-SEC-05.02</b> <b>SNG-SEC-05.03</b>
113	SNG-SEC-05.01	4.4.6.	The SNG shall be capable of supporting local entity authentication structures.	<b>SNG-SEC-05</b>	
114	SNG-SEC-05.02	4.4.7.	The SNG shall be capable of supporting peer entity authentication structures.	<b>SNG-SEC-05</b>	
115	SNG-SEC-05.03	4.4.8.	The SNG shall be capable of supporting shared secret credentials.	<b>SNG-SEC-05</b>	
116	SNG-SEC-06	4.4.9.	The SNG shall log startup.	452-SRD-USA 4.1.4.a	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
117	SNG-SEC-07	4.4.10.	The SNG shall log shutdown.	452-SRD-USA 4.1.4.b	
118	SNG-SEC-08	4.4.11.	The SNG shall log authentication.	452-SRD-USA 4.1.4.c	
119	SNG-SEC-09	4.4.12.	The SNG shall log authorization/permission granting.	452-SRD-USA 4.1.4.d	
120	SNG-SEC-10	4.4.13.	The SNG shall log action by trusted users.	452-SRD-USA 4.1.4.e	
121	SNG-SEC-11	4.4.14.	The SNG shall log process invocation.	452-SRD-USA 4.1.4.f	
122	SNG-SEC-12	4.4.15.	The SNG shall log unsuccessful data access attempts (threshold = log on five unsuccessful attempts).	452-SRD-USA 4.1.4.g	
123	SNG-SEC-13	4.4.16.	The SNG shall log data deletion.	452-SRD-USA 4.1.4.h	
124	SNG-SEC-14	4.4.17.	The SNG shall log data transfer.	452-SRD-USA 4.1.4.i	
125	SNG-SEC-15	4.4.18.	The SNG shall log configuration change.	452-SRD-USA 4.1.4.j	
126	SNG-SEC-16	4.4.19.	The SNG shall log application of confidentiality or integrity labels to data.	452-SRD-USA 4.1.4.k	
127	SNG-SEC-17	4.4.20.	The SNG shall log override or modification of data labels or markings.	452-SRD-USA 4.1.4.l	
128	SNG-SEC-18	4.4.21.	The SNG shall be capable of outputting log entries to removable media.	452-SRD-USA 4.1.4.m	
129	SNG-SEC-19	4.4.22.	The SNG shall be capable of outputting log entries to a printer.	452-SRD-USA 4.1.4.n	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
130	SNG-SEC-20	4.4.23.	The SNG shall be capable of outputting selected log entries to a local or remote Operator display.	MSES-2A-RPT-0367-0002(-) 4.4.23	
131	SNG-SEC-21	4.4.24.	Log records shall contain the following fields as a minimum: source, severity, timestamp, USA identifier of the person instigating the event or the person in control of the system, text field with the event data or description.	452-SRD-USA 4.1.4.o	
132	SNG-ENV-01	4.5.1.	The SNG shall successfully operate within the ambient temperature range available within the SN facility, thus not requiring modification of the temperature control capabilities of the SN facility.	452-SRD-USA 4.1.1.w	<b>SNG-ENV-01.01</b> <b>SNG-ENV-01.02</b>
133	SNG-ENV-01.01	4.5.2.	The SNG shall support an operating environment from 15 to 40 deg C	<b>SNG-ENV-01</b>	
134	SNG-ENV-01.02	4.5.3.	The SNG shall support a non-operating environment of -40 to 70 deg C	<b>SNG-ENV-01</b>	
135	SNG-ENV-02	4.5.4.	The SNG shall successfully operate within the ambient humidity range available within the SN facility, thus not requiring modification of the humidity control capabilities of the SN facility.	452-SRD-USA 4.1.1.x	<b>SNG-ENV-02.01</b> <b>SNG-ENV-02.02</b>
136	SNG-ENV-02.01	4.5.5.	The SNG shall be able to operate in 5% to 85% relative humidity, non-condensing environment.	<b>SNG-ENV-02</b>	
137	SNG-ENV-02.02	4.5.6.	The SNG shall be able to withstand without failure a 5% to 85% relative humidity, non-condensing environment while not in operation.	<b>SNG-ENV-02</b>	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
138	SNG-ENV-03	4.5.7.	The SNG shall be able to operate at altitudes from -200 feet to 10,000 feet.	MSES-2A-RPT-0367-0002(-) 4.5.7	
139	SNG-ENV-04	4.5.8.	The SNG shall be able to withstand without failure altitudes from -200 feet to 15,000 feet while not in operation.	MSES-2A-RPT-0367-0002(-) 4.5.8	
140	SNG-ENV-05	4.5.9.	The SNG shall produce less than 40 dB(A) weighted sound pressure level (SPL) measured at 6 feet.	MSES-2A-RPT-0367-0002(-) 4.5.9	
141	SNG-ENV-06	4.5.10.	When not operating and packaged in packing material supplied by the vendor, the SNG shall be able to withstand shock and vibration which consistent with travel by truck, rail, or pressurized air cabin without any damage.	MSES-2A-RPT-0367-0002(-) 4.5.10	
142	SNG-ENV-07	4.5.11.	The SNG shall be packaged in accordance with NPR 6000.1	MSES-2A-RPT-0367-0002(-) 4.5.11	
143	SNG-ENV-08	4.5.12.	The SNG shall sustain operating shock and vibration consistent with ANSI/SCTE 158 2009 for CLASS 3A equipment for operational and non-operating environments.	MSES-2A-RPT-0367-0002(-) 4.5.12	
144	SNG-ENV-09	4.5.13.	The SNG shall use EMI racks and filtering as required.	452-SRD-USA 7.4.c	
145	SNG-ENV-10	4.5.14.	The SNG shall comply with the USA system EMI requirements without using rack front doors or hiding controls and displays.	452-SRD-USA 7.4.d	
146	SNG-ENV-11	4.5.15.	The SNG shall comply with the requirements of FCC 47 CFR Part 15-2001 for electromagnetic interference (EMI) and electromagnetic control (EMC)	452-SRD-USA 7.4.a 452-SRD-USA 7.4.b	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
147	SNG-ENV-12	4.5.16.	The SNG shall be designed and constructed to comply with the requirements of STDN-SPEC-4, GSFC General Requirements for STDN Electronic Equipment, or best commercial practices.	452-SRD-USA 7.1.a	
148	SNG-ENV-13	4.5.17.	Connectors, cable, wires and other materials listed in STDN-SPEC-8, GSFC Specification for Electronic Equipment Installation Materials, or best commercial practices shall be used in the design and construction of SNG equipment, unless a waiver is received from the USA Product Design Lead.	452-SRD-USA 7.1.b	
149	SNG-ENV-14	4.5.18.	SNG equipment shall be mounted in Electronic Equipment Racks which conform to the interface requirements of EIA-310-D, Cabinets, Racks, Panels and Associated Equipment.	452-SRD-USA 7.2.a	
150	SNG-ENV-15	4.5.19.	Racks shall include tapped panel mounting holes.	452-SRD-USA 7.2.b	
151	SNG-ENV-16	4.5.20.	Racks shall accommodate standard 19-inch EIA equipment panels.	452-SRD-USA 7.2.c	
152	SNG-ENV-17	4.5.21.	All cable fabrication shall be in accordance with the requirements of STDN-SPEC-4, Section 3.7.	452-SRD-USA 7.3.a	
153	SNG-ENV-18	4.5.22.	All power and signal cables necessary for equipment operations shall be provided.	452-SRD-USA 7.3.b	
154	SNG-ENV-19	4.5.23.	All cabling between the SNG and WSC/GRGT systems shall be provided.	452-SRD-USA 7.3.c	
155	SNG-ENV-20	4.5.24.	All mating connectors shall be supplied.	452-SRD-USA 7.3.d	



# Requirements Traceability Verification Matrix



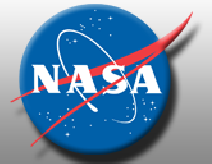
Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
156	SNG-ENV-21	4.5.25.	All cabling required for configuring the systems and subsystems for checkout and in-plant testing shall be provided. This includes cabling required at the WSGT/STGT and GRGT sites for all special test equipment.	452-SRD-USA 7.3.e	
157	SNG-ENV-22	4.5.26.	Cable color coding for Restricted IONet cables shall be pink (hot pink).	452-SRD-USA 7.3.h	
158	SNG-RMA-01	4.6.1.	Spares provisioning plan for the SNG shall be determined and provided by the development contractor for approval by NASA.	452-SRD-USA 8.2.3.a	
159	SNG-RMA-02	4.6.2.	The proposed spare parts and quantities shall be based upon satisfying the availability and maintainability requirements of this Requirements Document.	452-SRD-USA 8.2.3.b	
160	SNG-RMA-03	4.6.3.	It shall be ensured that either spare parts are available for a period of 15 years after Final Acceptance Testing or that NASA be provided advance notice of intent to discontinue manufacture of parts/components by all levels of subcontractors.	452-SRD-USA 8.2.3.c	
161	SNG-RMA-04	4.6.4.	The SNG implementation shall be supportable for at least 15 years through a combination of software updates and tech refresh operations.	MSES-2A-RPT-0367-0002(-) 4.6.4	
162	SNG-RMA-05	4.6.5.	The SNG implementation shall include redundant equipment required to meet the RMA requirements defined in this section.	452-SRD-USA 4.1.1.q	
163	SNG-RMA-06	4.6.6.	The SNG shall have an operational MTBF of greater than 50,000 hours.	MSES-2A-RPT-0367-0002(-) 4.6.6	



# Requirements Traceability Verification Matrix



Requirement		Source		Traceability	
Line	Req. ID	Paragraph	Statement	Parent	Children
164	SNG-RMA-07	4.6.7.	The SNG shall be able to detect a failure and allow operator intervention to switch from the primary to the redundant Gateway in less than 0.5 hours.	MSES-2A-RPT-0367-0002(-) 4.6.7	
165	SNG-RMA-08	4.6.8.	The SNG shall have an inherent MTBF of greater than 25,000 hours.	MSES-2A-RPT-0367-0002(-) 4.6.8	
166	SNG-RMA-09	4.6.9.	The SNG MTTR shall be less than 0.5 hours	452-SRD-USA 5.2.1.a	
167	SNG-RMA-10	4.6.10.	The SNG maximum time to repair shall be less than 1.0 hours for 90% of all failures.	452-SRD-USA 5.2.1.b	
168	SNG-RMA-11	4.6.11.	Failures shall be isolated to one chassis. Manual intervention can be used to isolate failures to below the chassis level.	452-SRD-USA 5.2.2.a	
169	SNG-RMA-12	4.6.12.	The Parts Count Reliability prediction method of MIL-HDBK-217 shall be used in the initial stages of system design to determine the MTTF.	452-SRD-USA 5.1.1.a	
170	SNG-RMA-13	4.6.13.	The reliability prediction method shall shift to the Parts Stress Analysis Prediction method, or other reliability modeling technique approved by NASA, at the time when a firm, detailed parts list is available to determine the MTBF.	452-SRD-USA 5.1.1b	
171	SMG-RMA-14	4.6.14.	Provision shall be made to ensure that software source code is available to provide continuing support for the SNG in the event of vendor bankruptcy or failure to perform.	MSES-2A-RPT-0367-0002(-) 4.6.14	
172	SNG-DOC-01	4.7.1.	All USA subsystem technical manuals shall be prepared in accordance with STDN-SPEC-1, Specification Preparation and Acceptance of Technical Manuals.	452-SRD-USA 7.1.d	



## **Section 3.4**

### **Interfaces**



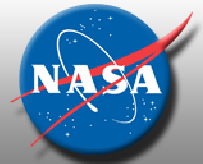
# Interfaces



- **Interface Control Documents (ICDs) will be developed**
  - LRDS-SNG, SNG-IONet, SNG-RBSP, SNG-GPM
- **Physical**
  - RS-422 to/from LRDS (one multi-pin connector)
  - Ethernet to/from Restricted IONet
- **Logical**
  - TCP/IP over Restricted IONet
  - SLE RAF and FCLTU to/from RBSP
  - LEO-T encapsulation to/from GPM over TCP/IP Sockets
  - SFTP to RBSP and GPM



# SNG Data Interfaces per Mission



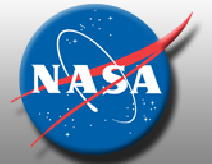
- **RBSP mission has two spacecraft**

RBSP	L&EO		Nominal		Contingency		Total	
	Return	Forward	Return	Forward	Return	Forward	Return	Forward
RS-422	1	1	2	2	2	2	2	2
IONet*	1	1	1	1	1	1	1	1

- **GPM-Core initially has one spacecraft**

GPM	L&EO		Nominal		Contingency		Total	
	Return	Forward	Return	Forward	Return	Forward	Return	Forward
RS-422	2	2	2	2	2	2	2	2
IONet*	1	1	1	1	1	1	1	1

\* IONet interface is Ethernet; return and forward connections are on same physical interface



## **Section 3.5**

# **Functional Architecture**



# SNG Functional Interfaces by Mission



## RBSP

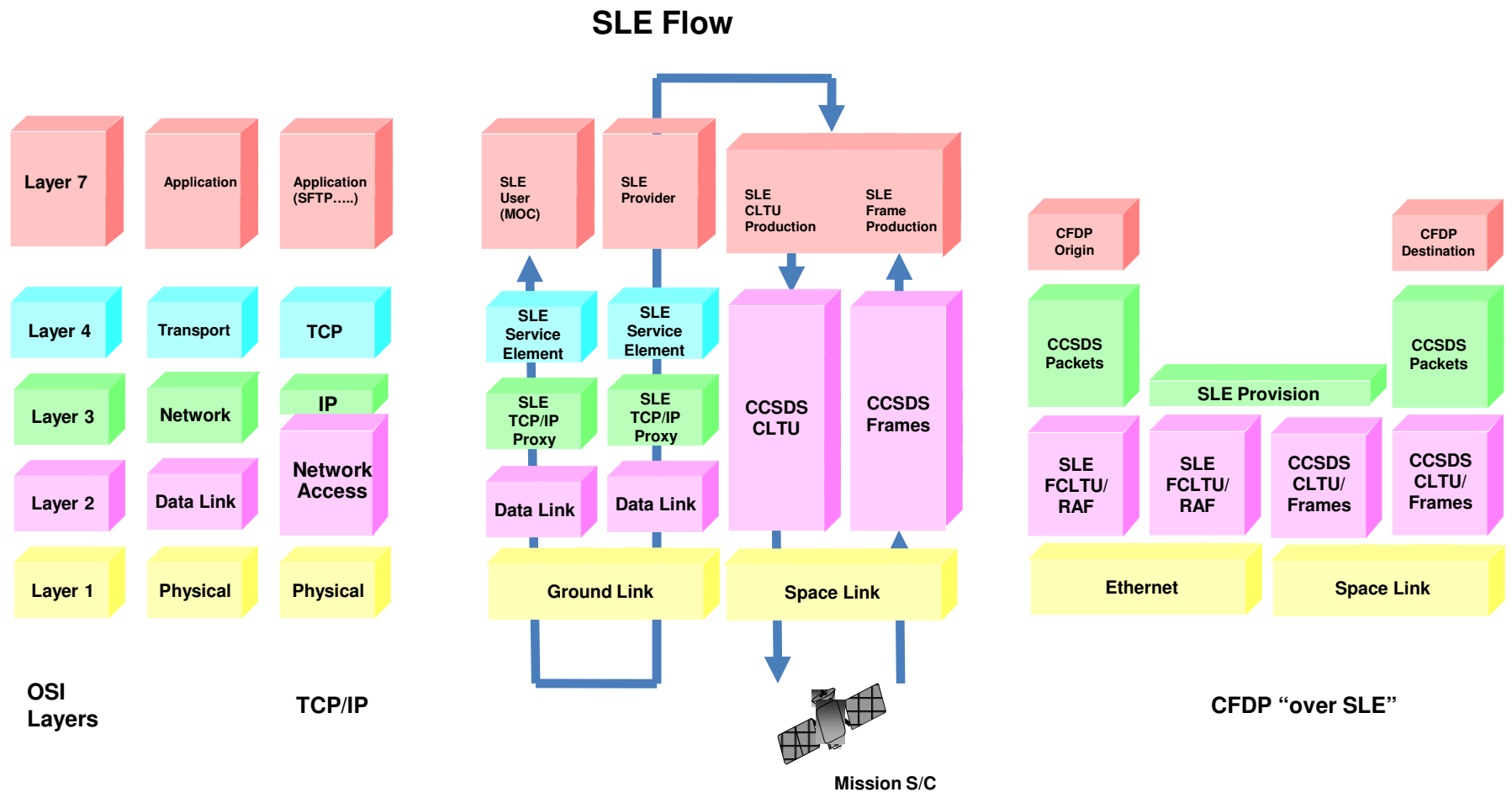
- Space Link Extension (SLE)
- Forward Link
  - SLE Forward Command Link Transmission Unit (FCLTU) service
- Return Link
  - SLE Return All Frames (RAF) Online Delivery
  - Secure FTP (SFTP) for Offline Delivery

## GPM

- White Sands Complex Data Interface Service Capability (WDISC) equivalent
- Forward Link
  - LEO-T CLTU Encapsulation
- Return Link
  - LEO-T VCDU Encapsulation
  - Secure FTP (SFTP) for Offline Delivery



# IP Services Mapping





# SLE Security



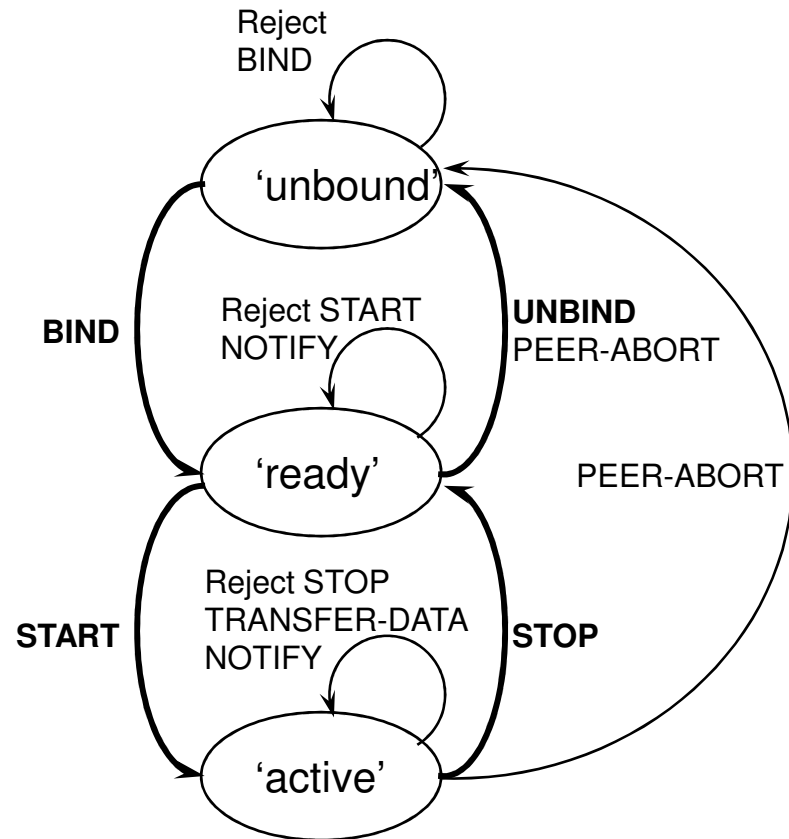
- **Data Privacy**
  - Data Privacy is not explicitly defined within SLE and should be ensured outside of the service
- **Data Integrity**
  - SLE service defines and enforces a strict sequence of operations that constrain the ability of a third party to inject operation invocations or returns into the transfer service association between a service user and provider
- **Authentication**
  - SLE service specification defines authentication requirements, and defines initiator-identifier, responder-identifier, invoker-credentials, and performer-credentials, parameters of the service operation invocations and returns that are used to perform SLE transfer service authentication. CCSDS provides cross support examples of authentication methods.



# SLE FCLTU and RAF Provider State Diagram



- **'Unbound'** – No association exists between user and provider
- **'Ready'** – An association has been established between user and provider, but no data may be accepted
- **'Active'** – The provider is capable of accepting data from an associated user.
- Minimum level of cross compatible security – authentication on **BIND**





# SLE RAF Operations



## Provider

- RAF-BIND\*
- RAF-UNBIND\*
- RAF-STATUS-REPORT
- RAF-TRANSFER-DATA
- RAF-SYNC-NOTIFY
- RAF-PEER-ABORT

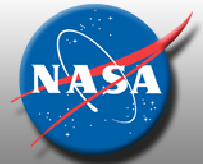
## User

- RAF-BIND\*
- RAF-UNBIND\*
- RAF-START\*
- RAF-STOP\*
- RAF-SCHEDULE-STATUS-REPORT
- RAF-GET-PARAMETER\*
- RAF-PEER-ABORT

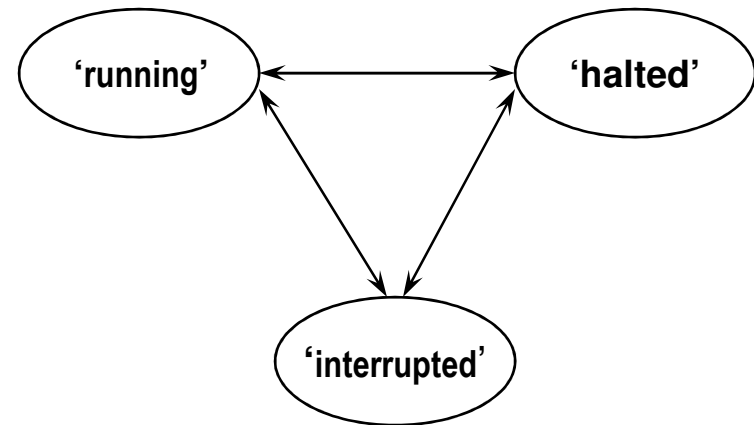
\*Has a response operation



# SLE RAF Production Status

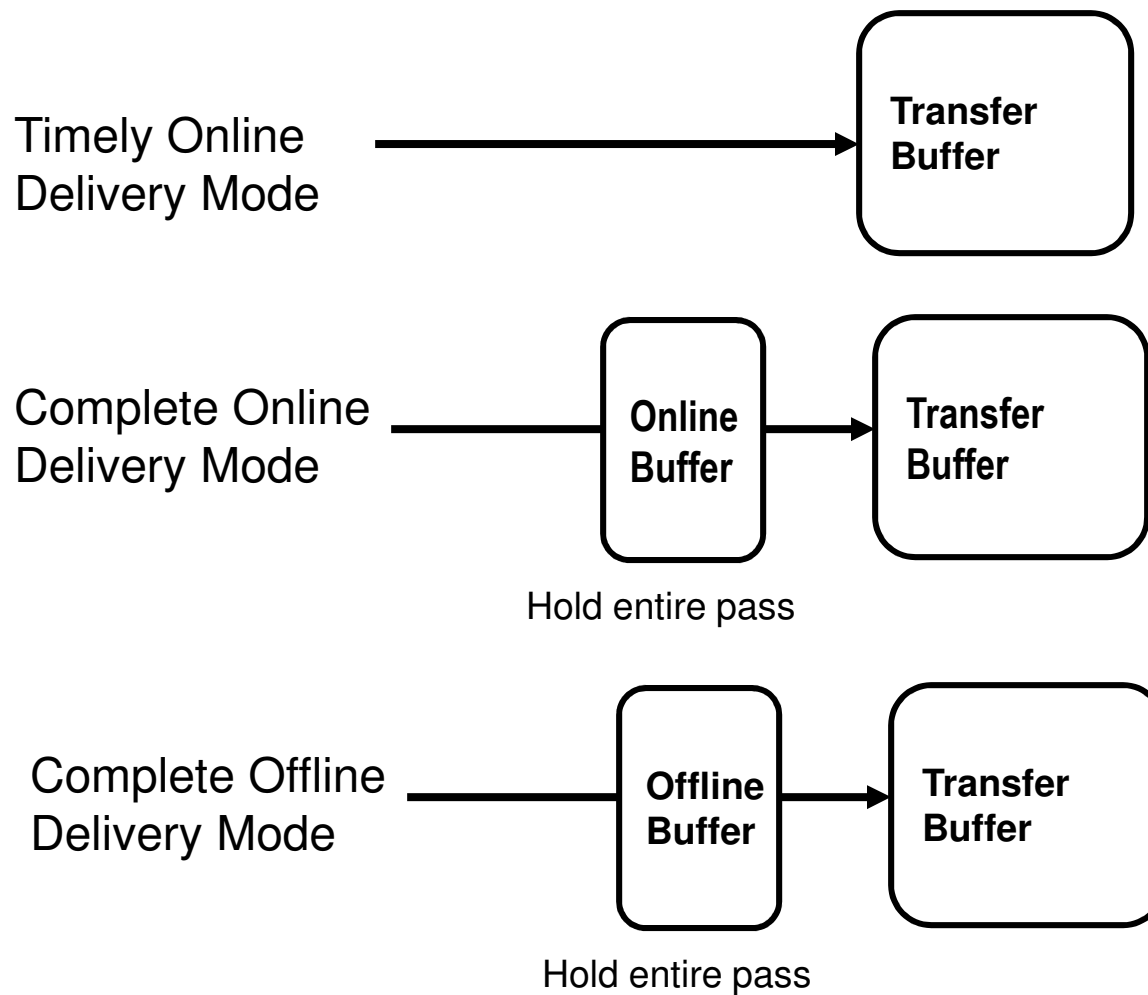


- **'Running'** – The RAF production process is capable of processing a return space link physical channel, if available
- **'Interrupted'** – The production process is stopped due to a fault
- **'Halted'** – The production process is stopped and production equipment is out of service due to management action





# SLE Return Delivery Modes





# SLE FCLTU Operations



## Provider

- CLTU-STATUS-REPORT
- CLTU-ASYNC-NOTIFY
- CLTU-PEER-ABORT

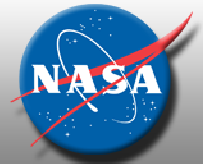
## User

- CLTU-BIND\*
- CLTU-UNBIND\*
- CLTU-START\*
- CLTU-STOP\*
- CLTU-SCHEDULE-STATUS-REPORT\*
- CLTU-GET-PARAMETER\*
- CLTU-TRANSFER-DATA\*
- CLTU-THROW-EVENT\*
- CLTU-PEER-ABORT

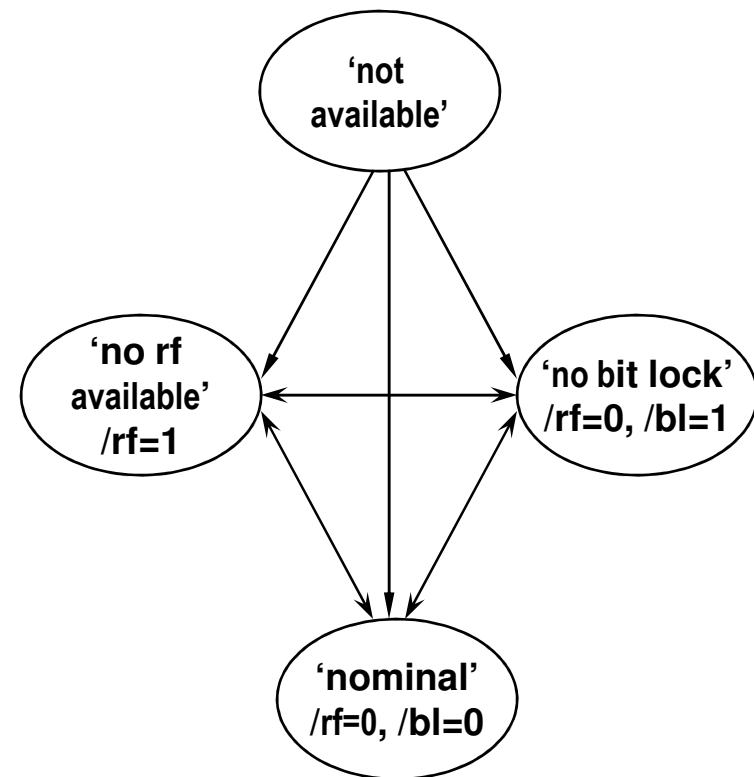
\*Has a response operation



# SLE FCLTU Uplink Status



- **'Not available'** – No Command Link Control Words (CLCW) from the spacecraft have been received by the provider.
- **'No RF available'** – In the last CLCW received from the provider, the 'No RF Available' bit was set to 1
- **'No bit lock'** – In the last CLCW received from the provider, the 'No RF Available' bit was set to 0 and the 'No Bit Lock' bit was set to 1
- **'Nominal'** – In the last CLCW received from the provider, the 'No RF Available' bit was set to 0 and the 'No Bit Lock' bit was set to 0
- If SLE Return Channel Frames (RCF) is not providing CLCW to the SLE FCLTU, the Uplink Status is not used

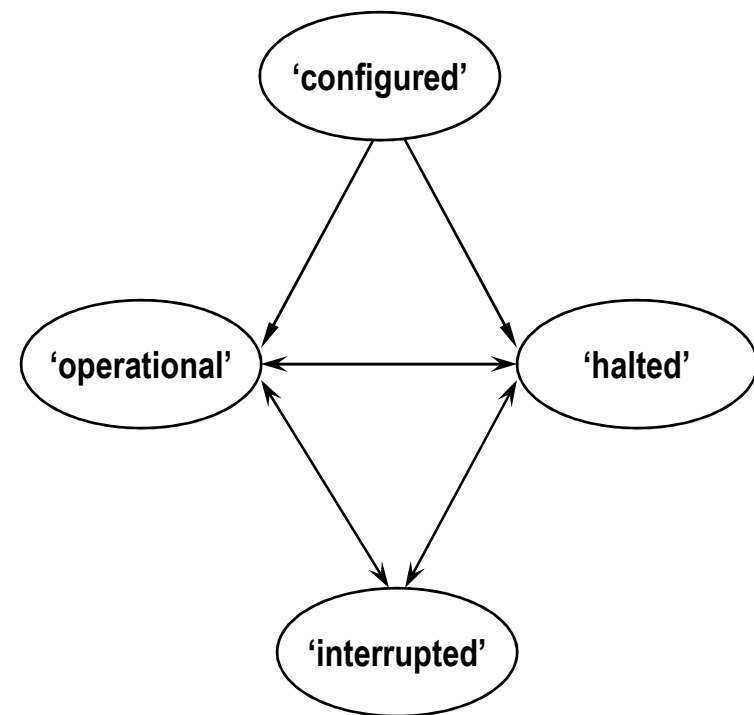




# SLE FCLTU Production Status



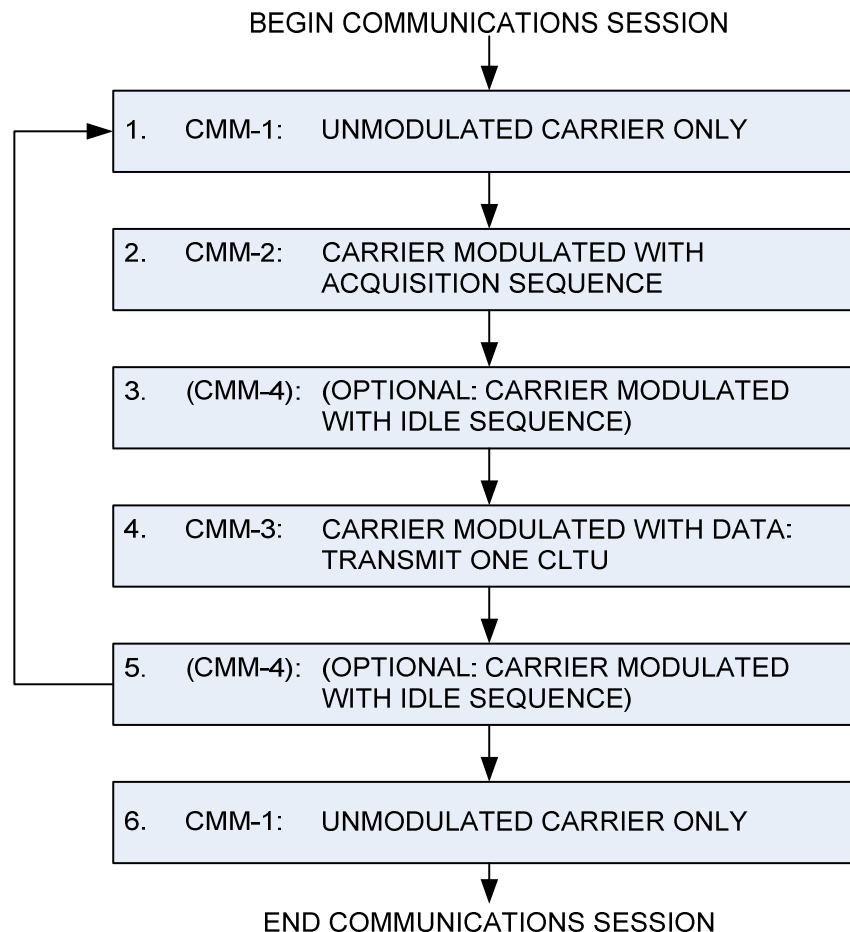
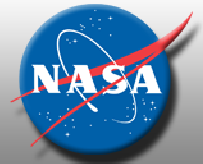
- **'Configured'** – Equipment has been assigned to support the service instance, but the production process is not yet capable of receiving CLTUs
- **'Operational'** – The production process has been configured for support, has completed the acquisition sequence, and is capable of radiating CLTUs
- **'Interrupted'** – The production process is stopped due to a fault
- **'Halted'** – The production process is stopped and production equipment is out of service due to management action





# Physical Layer Operations Procedures (PLOP)

## PLOP-1 CMM Sequence

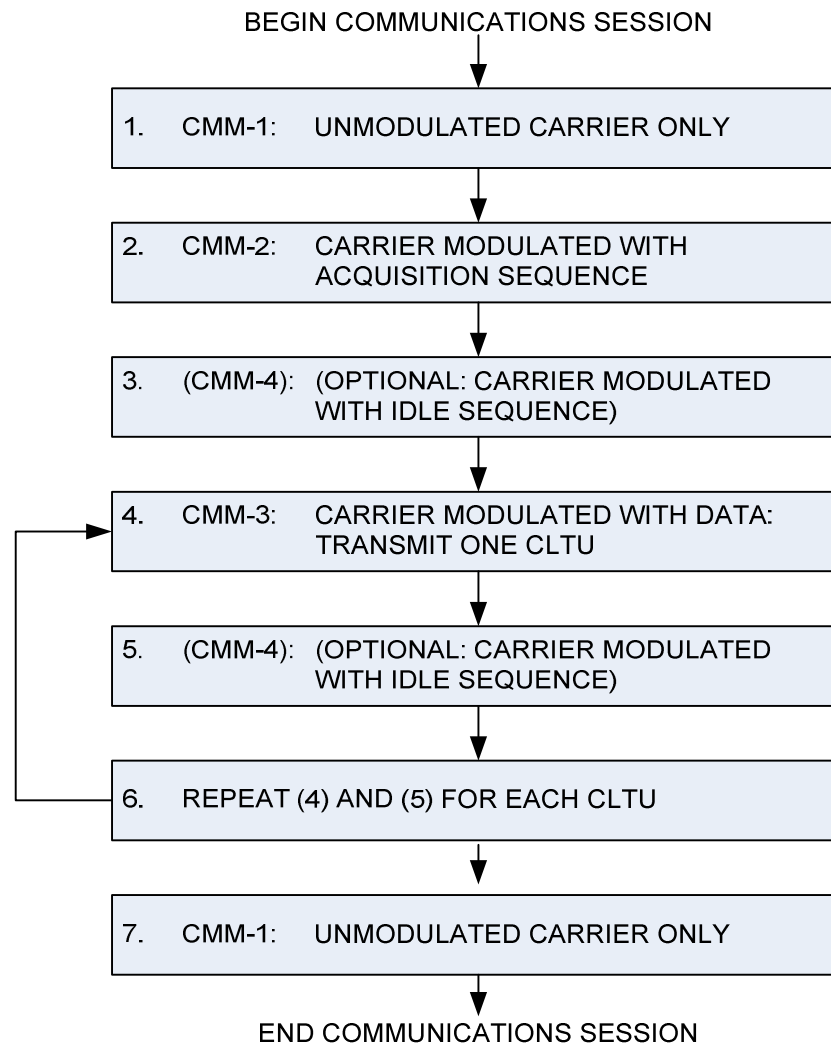


- **Physical Layer Operations Procedures (PLOP) is a sequence of Command Modulation Modes (CMM)**
- **Physical Channel is deactivated after each CLTU Transmission**
- **Not used by current mission set**



# Physical Layer Operations Procedures (PLOP)

## PLOP-2 CMM Sequence

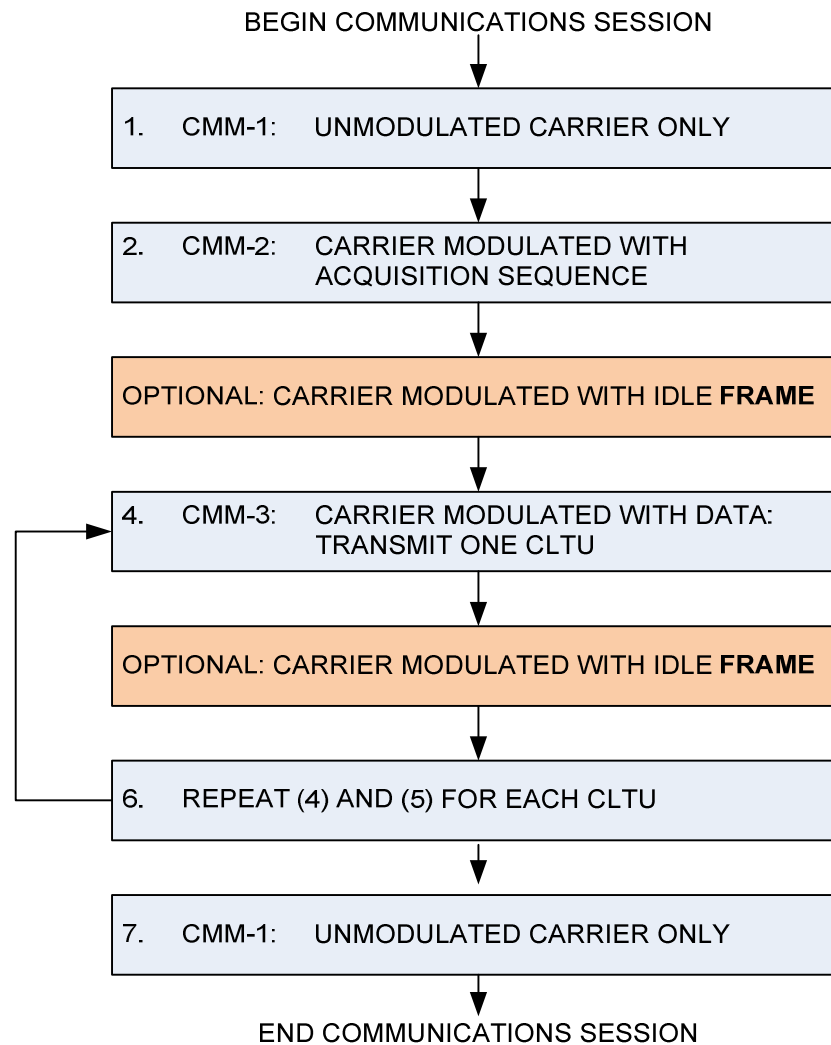


- **GPM and RBSP missions will use PLOP-2**
- **Similar to PLOP-1 except that after Acquisition, Physical Channel remains active throughout CLTU Transmission**



# Physical Layer Operations Procedures (PLOP)

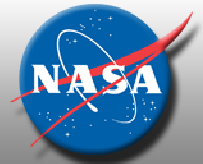
## PLOP-3 CMM Sequence



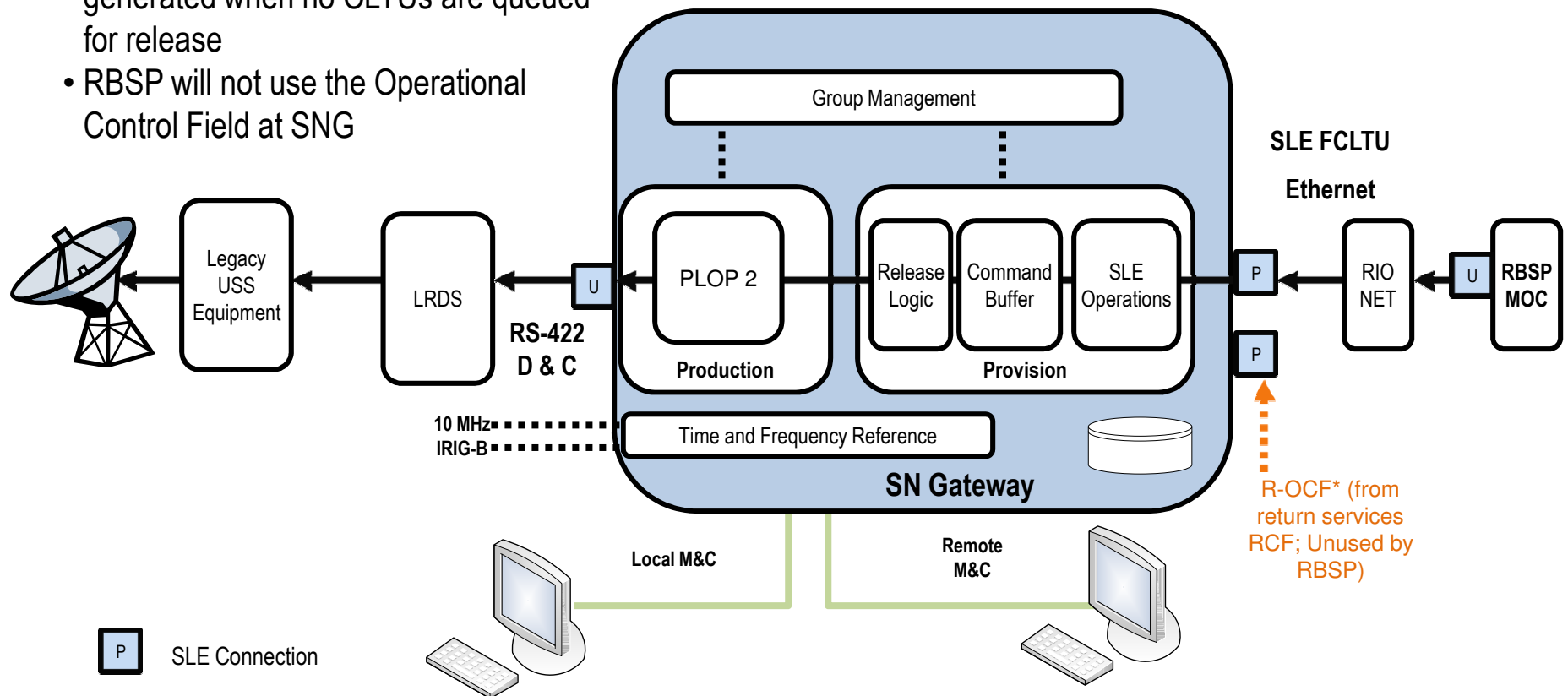
- **Not used by current mission set**
- **Required for CxP in future**
- **PLOP-3 is currently not at Blue Book level**
- **PLOP-3 implements synchronous idle frame generation**
- **After Acquisition, Physical Channel remains active throughout CLTU Transmission**



# Functional Architecture – RBSP FL

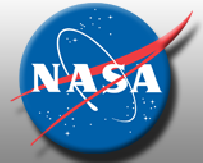


- RBSP MOC Sends Complete FCLTU “frames” to SN Gateway using SLE
- Per PLOP-2, idle sequence is generated when no CLTUs are queued for release
- RBSP will not use the Operational Control Field at SNG

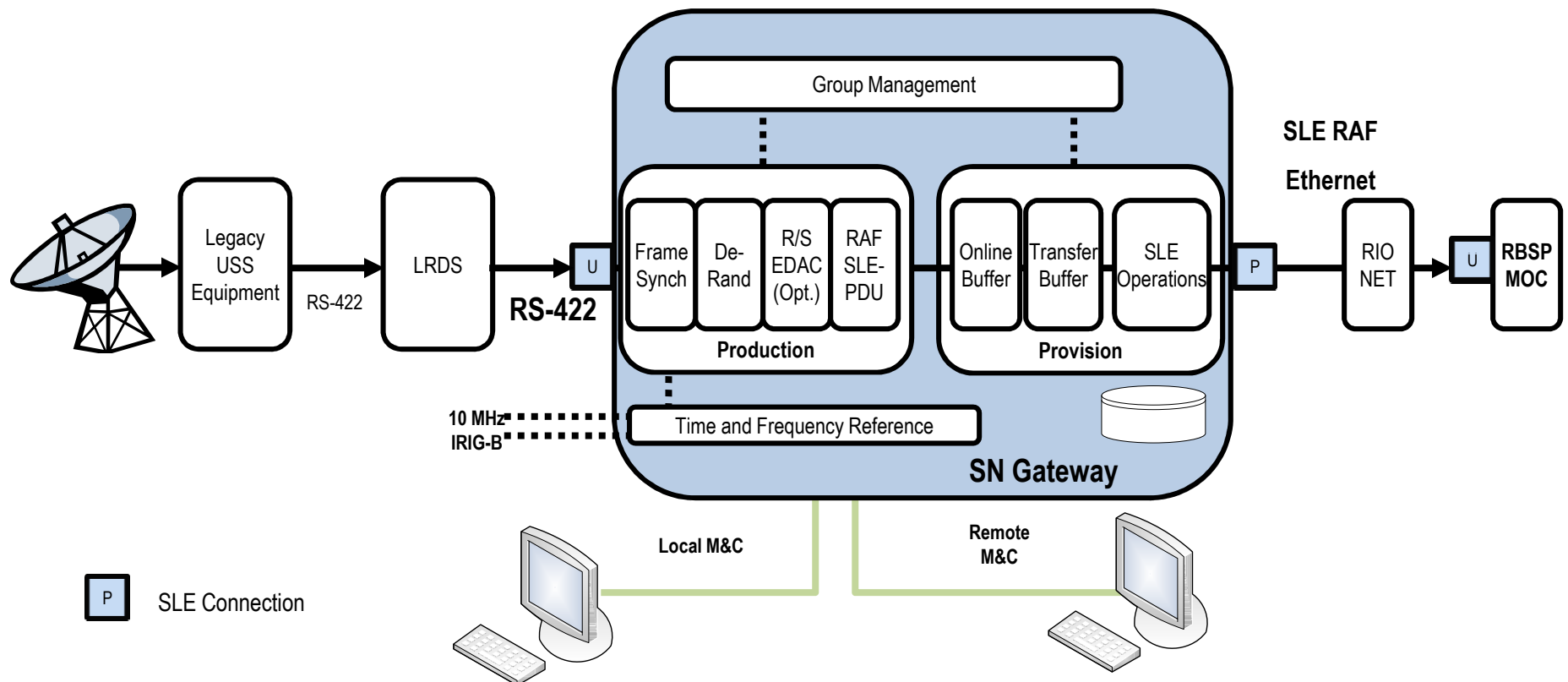




# Functional Architecture – RBSP RL



- RBSP MOC receives all return frames

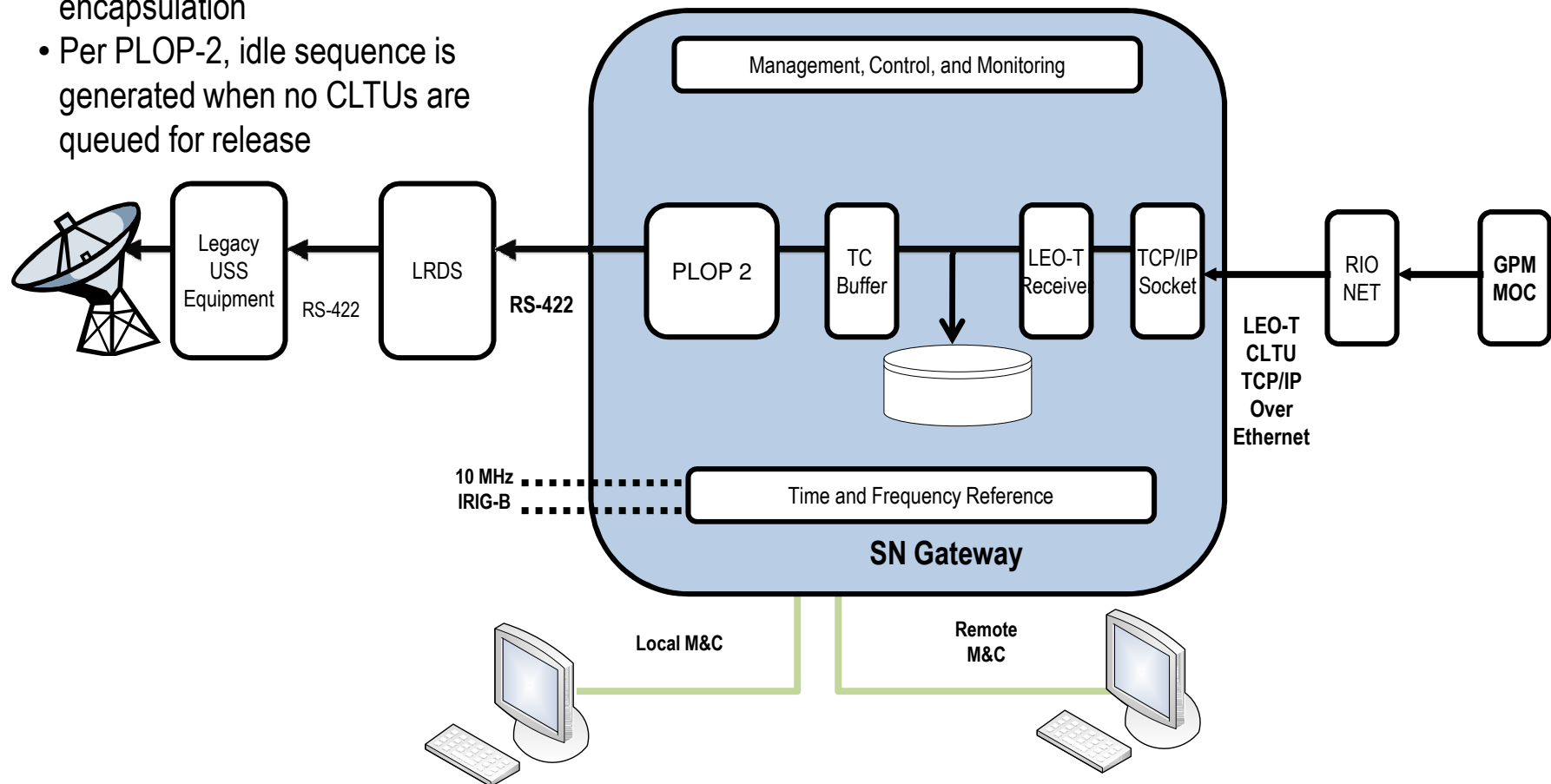




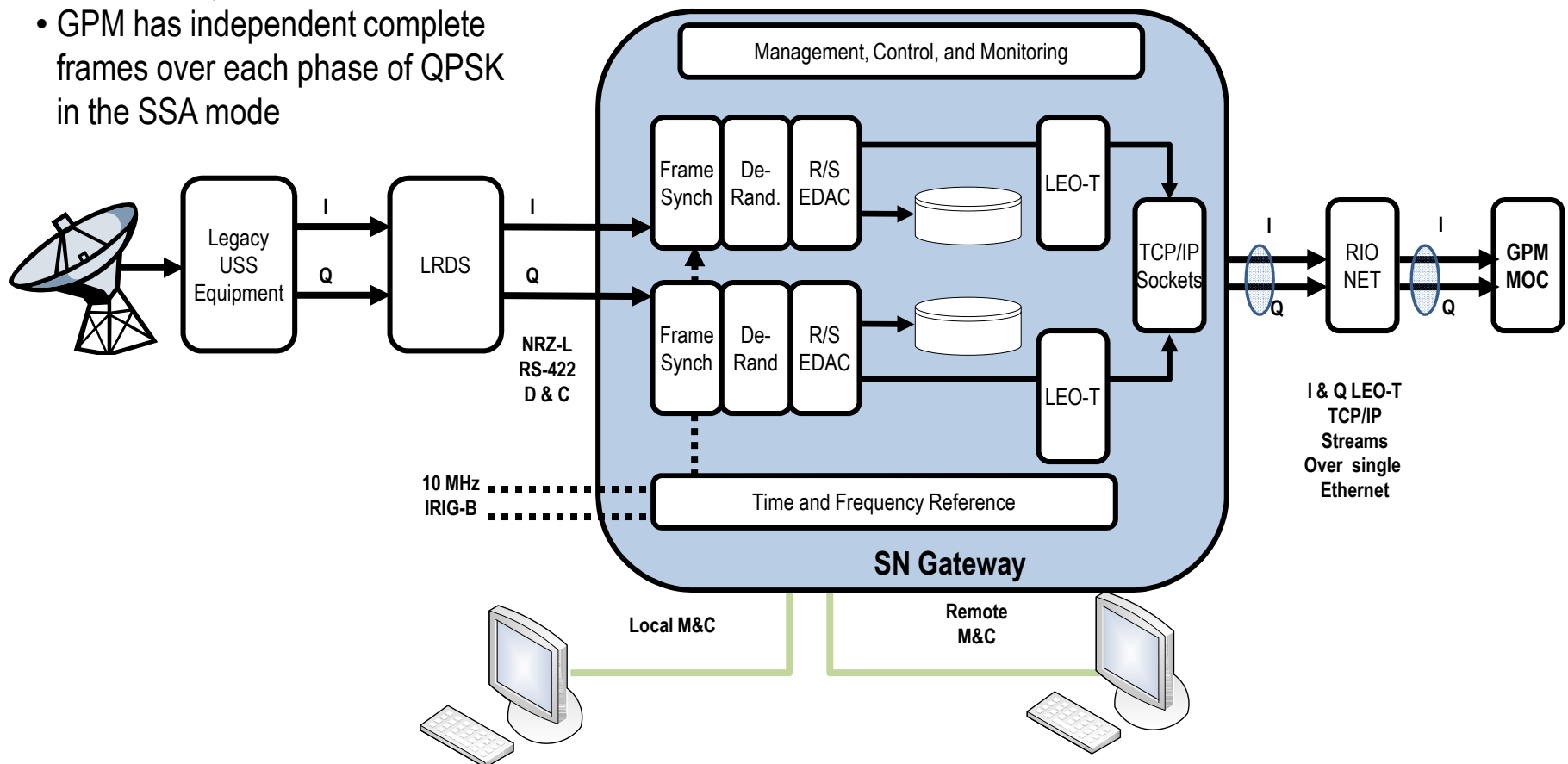
# Functional Architecture – GPM FL



- GPM MOC sends complete CLTUs transferred over IP using LEO-T encapsulation
- Per PLOP-2, idle sequence is generated when no CLTUs are queued for release

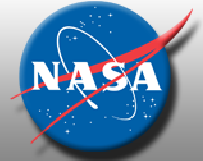


- GPM MOC receives VCDUs over IP using LEO-T encapsulation from SN Gateway
- GPM has independent complete frames over each phase of QPSK in the SSA mode

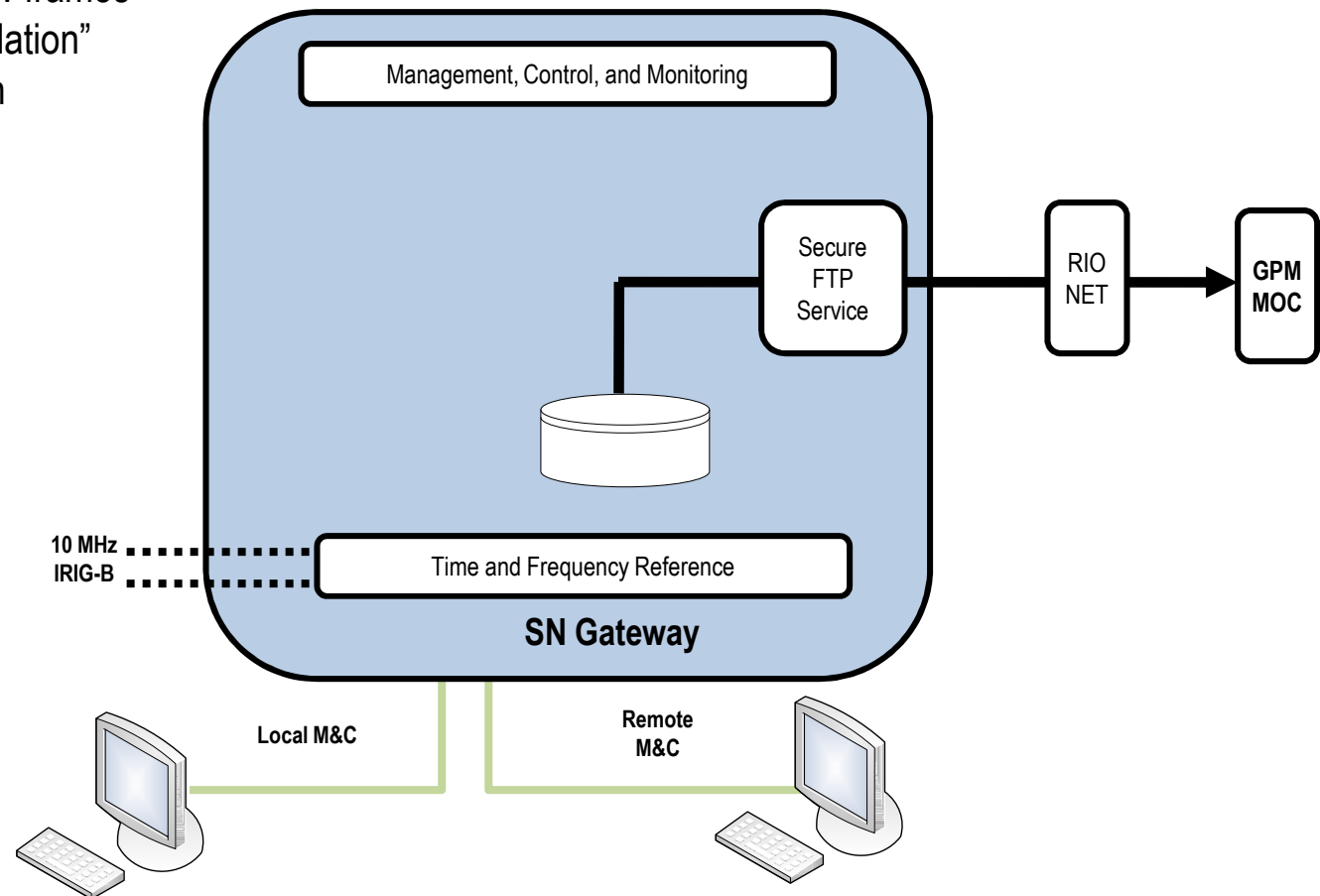




# Functional Architecture – GPM & RBSP Offline Access



- Mission MOC can transfer recorded corrected frames and/or raw frames
- RBSP: SLE PDU “encapsulation”
- GPM: LEO-T encapsulation



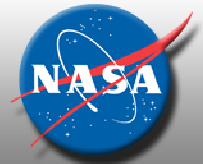


## **Section 3.6**

# **Verification & Validation**



# Verification Levels



Level	Test Name	Description
1	Component	<ul style="list-style-type: none"><li>• Vendor facility testing of HW and SW</li><li>• Vendor will conduct FAT</li></ul>
2	Unit	<ul style="list-style-type: none"><li>• Vendor facility testing of combined HW and SW</li><li>• Vendor will conduct FAT</li></ul>
3	Subsystem Integration	<ul style="list-style-type: none"><li>• First test of many interfaces, partial SRD verified</li><li>• DTTF assembly and interoperability testing of SNG</li></ul>
4a	System Integration	<ul style="list-style-type: none"><li>• Assembly of end-to-end system</li><li>• DTTF ↔ RBSP/GPM testing of SNG</li></ul>
4b	System Integration	<ul style="list-style-type: none"><li>• Establishment of baseline, full SRD verified*</li><li>• SMTF ↔ RBSP/GPM testing of SNG</li></ul>
5	System Acceptance	<ul style="list-style-type: none"><li>• Full SRD verification and validation</li><li>• WSC Operations ↔ RBSP/GPM testing of SNG</li></ul>

\* All SRD requirements necessary for initial RBSP and GPM support verified



# Verification Players



Test Level	Participants & Products				
	Vendor	SNG Project	RBSP & GPM	USA/NASA	WSC M&O
<b>1</b> Component Test	<ul style="list-style-type: none"> <li>• Test Plans</li> <li>• Procedures</li> <li>• Test Conduct</li> </ul>	<ul style="list-style-type: none"> <li>• Witness</li> </ul>		<ul style="list-style-type: none"> <li>• Witness as desired</li> </ul>	
<b>2</b> Unit Test	<ul style="list-style-type: none"> <li>• Test Plans</li> <li>• Procedures</li> <li>• Test Conduct</li> </ul>	<ul style="list-style-type: none"> <li>• Witness</li> </ul>		<ul style="list-style-type: none"> <li>• Witness as desired</li> </ul>	
<b>3</b> Subsystem Integration	<ul style="list-style-type: none"> <li>• Direct Support</li> </ul>	<ul style="list-style-type: none"> <li>• Test P&amp;Ps</li> <li>• Test Conduct</li> <li>• Reports</li> </ul>		<ul style="list-style-type: none"> <li>• DTF</li> <li>• Witness as desired</li> </ul>	<ul style="list-style-type: none"> <li>• Test Conduct</li> </ul>
<b>4a</b> Subsystem Integration	<ul style="list-style-type: none"> <li>• Reachback Support</li> </ul>	<ul style="list-style-type: none"> <li>• Test P&amp;Ps</li> <li>• Test Conduct</li> <li>• Reports</li> <li>• Support Missions</li> </ul>	<ul style="list-style-type: none"> <li>• Test P&amp;Ps</li> <li>• Test Conduct</li> <li>• Test Data</li> <li>• Communications</li> </ul>	<ul style="list-style-type: none"> <li>• DTF</li> <li>• Witness</li> </ul>	<ul style="list-style-type: none"> <li>• Test Conduct</li> </ul>
<b>4b</b> System Integration	<ul style="list-style-type: none"> <li>• Reachback Support</li> </ul>	<ul style="list-style-type: none"> <li>• Test P&amp;Ps</li> <li>• Test Conduct</li> <li>• Reports</li> <li>• Support Missions</li> </ul>	<ul style="list-style-type: none"> <li>• Test P&amp;Ps</li> <li>• Test Conduct</li> <li>• Test Data</li> <li>• Communications</li> </ul>	<ul style="list-style-type: none"> <li>• Witness</li> </ul>	<ul style="list-style-type: none"> <li>• SMTF</li> <li>• Test Conduct</li> </ul>
<b>5</b> System Acceptance	<ul style="list-style-type: none"> <li>• Reachback Support</li> </ul>	<ul style="list-style-type: none"> <li>• Test P&amp;Ps</li> <li>• Test Conduct</li> <li>• Support WSC</li> </ul>	<ul style="list-style-type: none"> <li>• Test Conduct</li> <li>• MOC Simulation</li> </ul>	<ul style="list-style-type: none"> <li>• Witness</li> </ul>	<ul style="list-style-type: none"> <li>• Test Conduct</li> <li>• Operation</li> <li>• Errata</li> </ul>



# Verification Methods



- Inspection
  - Visual examination of product for physical or data characteristics
  - Minor role in SNG, since most requirements are not physical
- Analysis
  - Mathematical modeling and analytical techniques
  - Minor role in SNG due to availability of test articles
- Demonstration
  - Operation of the system to demonstrate compliant performance
  - Expected to be significant SNG verification method
- Test
  - Operation of the system to gather quantitative data metrics
  - Expected to be significant SNG verification method



# Verification & Validation



- **RTVM provides traceability from requirements to verification plans**
- **Validation performed through full scope verification and iteration with stakeholders**
  - Meetings with SN (USA Weekly, SN SEWG)
  - Meetings with RBSP and GPM (bi-weekly meetings)
  - SRR

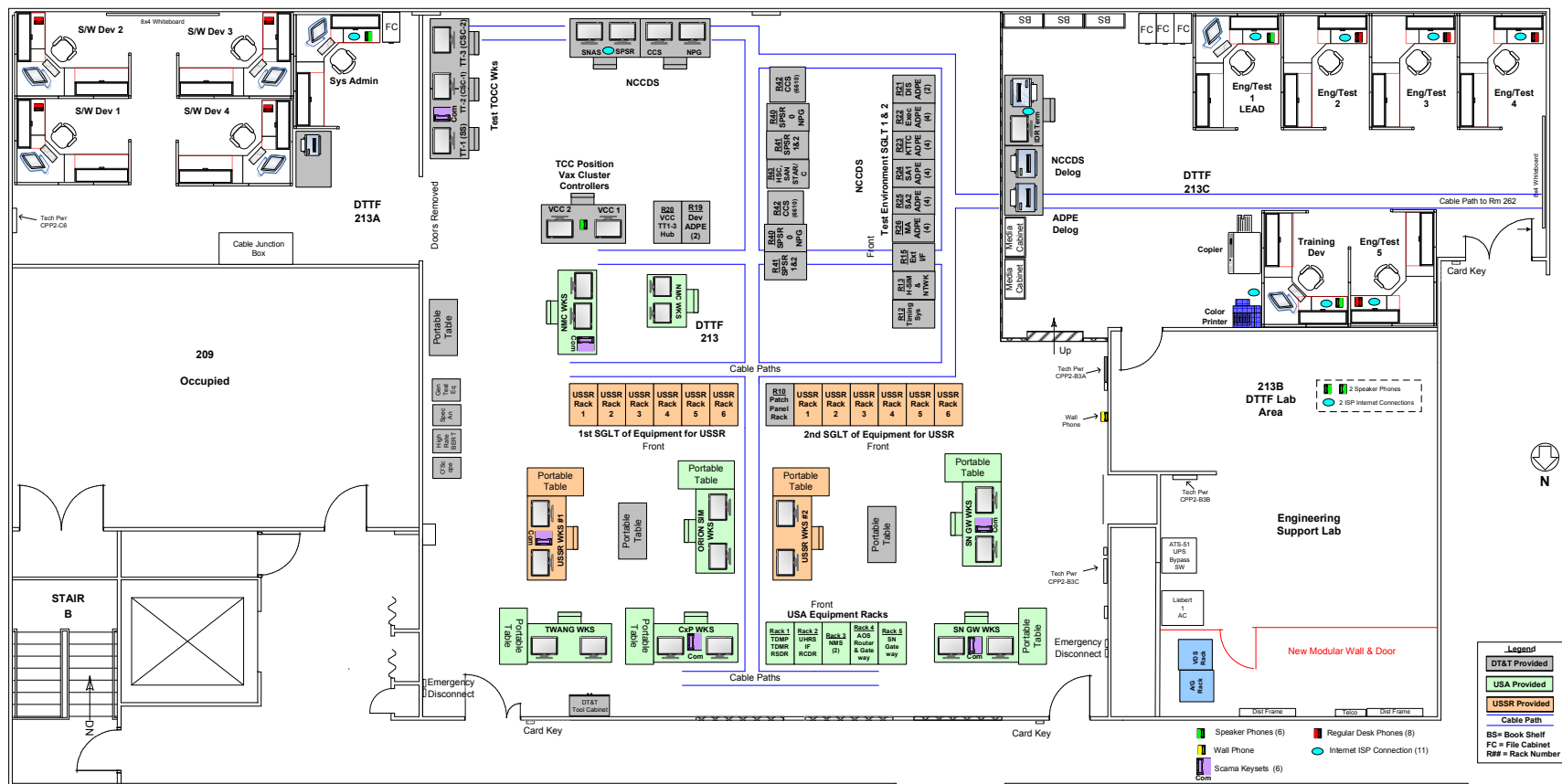


## **Section 3.7**

# **Integration & Test**



# DTTF Usage



DT&T Room 213 Floor Plan  
Revision: 12  
Date: 10/14/09  
Drawn By: Jo Ann Sidotti  
Checked By: Bill Wells

## Building 13 Development Test & Training Facility (DTTF) : USU (USA & USSR)

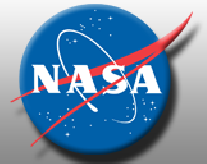
11/16/2009

SN Gateway Systems Requirements Review

108



# Test & Deployment Phasing Concept



Test & Deployment Phasing Concept				
Time →				
SNG #1	DTTF	DTTF	DTTF	DTTF
SNG #2	DTTF	SMTF	SMTF	SMTF
SNG #3		DTTF	STGT	STGT
SNG #4			DTTF	WSGT

- Hardware does not pass through SMTF on way to operations
- SNG proven in DTTF and SMTF
- Configuration controlled copies



**Section 4.0**

**Risk Management**

**Pat Boldosser**



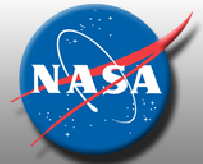
# Risks and Mitigation Overview



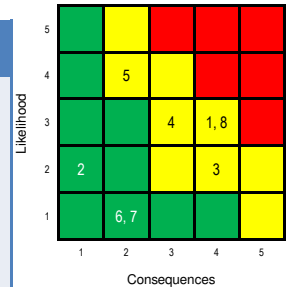
- **SNG is following the documented NASA risk methodology and will report risks at the USA project level.**
- **The risk number is the sequential identifier assigned to a risk.**
- **Potential mitigation approaches have been identified for each risk.**
- **The risk status is the tracking mechanism for the progress of those actions implemented to curtail a risk.**



# Risk

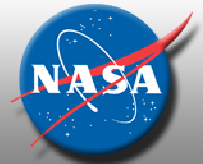


Risk ID	Risk Title	Risk Description	Likelihood	Consequences	Severity	Mitigation Plan
1	RBSP, GPM Requirements documentation	SNG Project has not received documented requirements from either mission, raising the possibility that they could be misunderstood or that they will change during the design and implementation process.	3	4	12	1. Contact Missions to provide documented requirements 2. Meet with missions regularly to keep them apprised of design maturity. 3. Receive written agreement to the final SNG SRD. 4. Missions are included on the SRR board.
2	WSC Operational Impacts	Given that the SN Gateway will be integrated into an existing operational system there is a possibility there will be delays in integration due to critical mission/site operations activities resulting in delay in testing and transition to operations	2	1	2	1. Coordinate installation schedule with WSC operational staff while system is being tested in DTF and SMTF. 2. SEWG facilitates open communication
3	Test Equipment	If test equipment is not identified before Level 3 test begins, schedule and cost impacts will arise.	2	4	8	1. Identify test Scenarios 2. Identify Test Equipment needed.
4	SLE Equipment compatibility	If various vendor SLE implementations are not compatible, then cost impacts will arise due to the need to buy multiple vendor equipment.	3	3	9	1. Appropriate the Avtec and RT Logic-delivered SLE equipment at the DTF and run compat testing between them. 2. Run compat testing between the vendor equipment and mission SLE implementations.
5	Low Data Rate Requirements	If low data rates cause unacceptable latency, a currently undefined design solution must be found.	1	2	2	1. RFI to industry will determine the scope of the problem. 2. Incorporate solution into design.
6	Interface definition	If the LRDS interface is different than expected, a different data interface design will be needed.	1	2	2	1. Draft a SNG-LRDS ICD. 2. Receive NASA and WSC approval.
7	Security Requirements	If Security Requirements impact performance or functionality, cost or schedule impacts could arise.	3	4	12	1. Test against security requirements and verify functionality. 2. Waivers if necessary.





# Technology Readiness Level



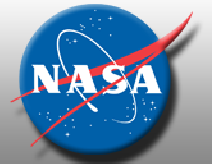
TRL	Maturity	Meaning	SNG Components
9	Flight	"Flight proven" through successful mission operations	SLE RAF SLE RCF LEO-T TCP/IP UDP/IP
8	Capability Development	"Flight qualified" through test and demonstration in a ground or space environment	
7		System prototype demonstration in a space environment	SLE FCLTU
6	Maturing Technology	Prototype demonstration in ground or space environment	
5		Component validation in relevant environment	
4		Component validation in laboratory environment	
3	Advanced Technology Research	Analytical and experimental proof-of-concept	
2		Technology concept formulated	
1	Fundamental Research	Basic principles observed and reported	



# Safety



- **SGT MSES Safety Officer has reviewed SNG and determined:**
  - SNG poses no system safety risk
  - SNG requires no special safety considerations



## **Section 5.0**

### **Wrap Up**



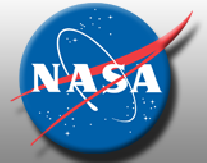
# SRR Success Criteria



- ✓ • Sound process for requirements allocation and control
- ✓ • Defined plan to complete definition within schedule
- ✓ • Allocation and derivation of key requirements complete down to subsystem level
- ✓ • Major external and internal interfaces defined
- ✓ • Preliminary V&V approach defined
- ✓ • Major risks identified and assessed, viable mitigation strategies defined



# RFA Creation & Review



- **All RFAs will be addressed in Final SRD**
  - RFAs due no later than 11/17/09
  - Final SRD due no later than 12/16/09



## **BACKUP SLIDES**

### **Acronym Definitions**



# Acronyms



Acronym	Meaning	Acronym	Meaning
CCB	Configuration Control Board	GRGT	Guam Remote Ground Terminal
CCR	Configuration Change Request	GSFC	Goddard Space Flight Center
CCSDS	Consultative Committee for Space Data Systems	ICD	Interface Control Document
CLTU	Command Link Transmission Unit	IF	Intermediate Frequency
COTS	Commercial-Off-The-Shelf	IONet	Internet Protocol (IP) Operational Network
DAS	Demand Access System	IP	Internet Protocol
DCN	Document Control Notice	IPv4	Internet Protocol, Version 4
FCLTU	Forward Command Link Transmission Unit	IPv6	Internet Protocol, Version 6
FEC	Forward Error Correction	IT	Information Technology
GDIS	Guam Data Interface System	ITSSP	Information Technology Systems Security Plan
GHz	Gigahertz	KaSA	Ka-Band Single Access



# Acronyms



Acronym	Meaning	Acronym	Meaning
KaSAF	Ka Band Single Access Forward	MAF	Multiple Access Forward
KaSAR	Ka Band Single Access Return	MAR	Multiple Access Return
Kbps	Kilobits per second	Mbps	Megabits per second
KuSA	Ku-Band Single Access	MHz	Megahertz
KuSAF	Ku Band Single Access Forward	MOC	Mission Operations Center
KuSAR	Ku Band Single Access Return	NASA	National Aeronautics and Space Administration
LAN	Local Area Network	NISN	NASA Integrated Services Network
LDR	Low Data Rate	NPR	NASA Procedural Requirements
LI	Local Interface	NTP	Network Time Protocol
M&C	Monitor and Control	OCD	Operations Concept Document
MA	Multiple Access	PDU	Protocol Data Unit



# Acronyms



Acronym	Meaning	Acronym	Meaning
PN	Pseudo Noise	SLE	Space Link Extension
PSK	Phase Shift Keying	SMA	S-Band Multiple Access
QPSK	Quadrphase Shift Keying	SMAF	S-Band Multiple Access Forward
RAF	Return All Frames	SMAR	S-Band Multiple Access Return
RCF	Return Channel Frames	SMTF	Software Maintenance and Training Facility
RF	Radio Frequency	SN	Space Network
RSDR	Return Service Data Recording	SNAS	Space Network Access System
RSR	Return Service Recording	SNUG	Space Network Users' Guide
SDU	Service Data Unit	SRD	System Requirements Document
SFTP	Secure File Transfer Protocol	SSA	S-Band Single Access
SGLT	Space-Ground Link Terminal	SSAF	S-Band Single Access Forward



# Acronyms



Acronym	Meaning
SSAR	S-Band Single Access Return
STGT	Second TDRSS Ground Terminal
TBD/TBR	To Be Determined/To Be Reviewed
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TOCC	TDRSS Operations Control Center
USA	User Service Access
USSR	User Service Subsystem Replacement
WDISC	WSC TCP/IP Data Interface Services Capability
WSC	White Sands Complex
WSGT	White Sands Ground Terminal